

Open Research Online

The Open University's repository of research publications and other research outputs

Automating managers : The implications of information technology for managers in five manufacturing companies

Thesis

How to cite:

Moss-Jones, John (1987). Automating managers : The implications of information technology for managers in five manufacturing companies. PhD thesis The Open University.

For guidance on citations see [FAQs](#).

© 1987 The Author



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Version: Version of Record

Link(s) to article on publisher's website:

<http://dx.doi.org/doi:10.21954/ou.ro.0000d4a1>

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

oro.open.ac.uk

DX 80891

UNRESTRICTED

HDN 2938

AUTOMATING MANAGERS
THE IMPLICATIONS OF INFORMATION TECHNOLOGY
FOR
MANAGERS IN FIVE MANUFACTURING COMPANIES

TWO VOLUMES
VOLUME I

JOHN MOSS-JONES, B.Sc. (Hons)., M.S.

Submitted for the Degree of Doctor of Philosophy

Faculty of Technology : Technology Policy Group

Author's Number: HDN 2938

Date of Submission: June 1987

Date of Award: 24th July 1987

OPEN UNIVERSITY

June 1987

Declaration page not scanned
at the request of the
University

AUTOMATING MANAGERS

THE IMPLICATIONS OF INFORMATION TECHNOLOGY FOR MANAGERS IN FIVE MANUFACTURING COMPANIES

ABSTRACT

Managers are universally regarded as key to the fortunes of organizations, yet there has been little focus on the effects of information technology (I.T.) on this group. In this research, the implications of I.T. for the work and roles of managers were studied, primarily in office settings, in five manufacturing companies in the Northern Home Counties.

The cases provided a wide range of both organizational cultures and I.T. use. Data were obtained largely through 101 semi-structured interviews with managers in various hierarchical and functional positions. Supporting material came from questionnaires and documents, and through informal observation on the 49 visits to companies.

I.T. consists of several interwoven and rapidly developing computing and communications technologies, and is interacting with the extremely varied environments found in the companies. There is no revolution. Rather I.T. use is growing from its precursors - telex, punched-card machines and earlier computers, and is conditioned powerfully by existing cultures. Gradually, however, the inherent character of the technology is changing practices in general, and management work in particular, in radical ways.

The fundamental nature of managers' work is little altered by I.T. It remains fragmented; weakly defined; oral; action-orientated. Increased productivity and reduced numbers of staff are consequences of I.T., and these, together with the increase in conceptual and systems skills amongst the work-force, are reducing the hierarchical-authority model of people management, and creating a more "professional-team" culture. The increasing effectiveness of information management that I.T. confers is producing other major consequences for managers. Information management is becoming a central component of their work. Overall, managers are having to adapt to increasingly technological, systematised environments, with smaller, more skilled staff teams. The transitions for managers are difficult, especially as companies have given slight attention to preparing managers for these changes, or indeed to management development in general.

JOHN MOSS JONES

Submitted for a Degree of Doctor of Philosophy
OPEN UNIVERSITY

June 1987

ACKNOWLEDGEMENTS

My thanks go to the many people who helped me throughout this research. Most of all to Dr. David Wield who taught and counselled me with such patience, and to Doreen Stevens who matched that patience in typing from my unreadable script.

The level of co-operation and assistance from the five companies involved was huge - without exception managers unstintingly gave me time from their busy schedules.

And of course I am indebted to Dr. Roy Steed, former Director of Luton College of Higher Education, and especially to my colleague-friends in the Centre for Management Studies at Putteridge Bury who constantly helped me maintain momentum in what has been a great learning experience.

The urge behind automation is economy of operation and production, expressing itself not only in a more effective use of human effort but also in a greater precision and reliability of working than can be obtained by other means. But the solution of the complex technical problems involved and the definition of the operational procedures inherent in the new methods of working depend not on machines but on the use we make of our human resources, in particular on the training we are prepared to give and undergo. Automation will not make robots of us all. On the contrary it will demand wider knowledge, greater ability and a higher degree of skill from worker and manager alike.

Automation: A report on the technical trends and their impact on management and labour. H.M.S.O. 1956

The benefits of information technology are something of a 'promised land': you have to endure a veritable wilderness of sensitive, ferociously complicated, and far-reaching decision making in order to get there, not to mention some large expenditures; and it still doesn't work as you had hoped. Indeed, for every major blessing it brings, as likely as not there will be a clutch of nasty little curses. If the new system is infuriating when it doesn't do what it's supposed to, it may be more infuriating when it does.

Preface to 'The Process of Introducing Information Technology'. K.D. EASON, Behaviour and Information Technology, Vol. 1, No. 2, 1982.

LIST OF CONTENTS

	<u>Page</u>
Title Page	
Abstract	ii
Acknowledgements	iii
List of Contents	iv - ix
List of Figures	x - xi

CHAPTER ONE : INTRODUCTION

1.1	Preface	1
1.2	Technology, Society and Work	1
1.3	Managerial Work	3
1.4	Themes in the Literature	3
1.5	Layout of the Thesis	5

CHAPTER TWO : INFORMATION TECHNOLOGY AND MANAGERS

2.1	The Organizational Context	7
2.2	Technology and Change : The General Case	16
2.3	Information Technology	20
2.4	Management Processes and System	38
2.5	The Implications Framework	49

CHAPTER THREE : RESEARCH METHOD

3.1	The Methodological Debate	53
3.2	Studying Managers	54
3.3	Method for this Research	59
3.4	Choice of Companies	63
3.5	The Sample of Managers	65
3.6	Format of the Case Presentations	69

CHAPTER FOUR : INFORMATION TECHNOLOGY AND
MANAGERS IN FIVE MANUFACTURING COMPANIES

<u>- THE CASE MATERIAL</u>	72
<u>'ENGINEERING'</u>	73
1. The Company	73
1.1 History	73
1.2 Organization	75
1.3 The Study	75
1.4 The Summary	77
2. I.T. Implementation	78
2.1 The I.T. Culture	78
2.2 I.T. Application	83
3. The Character of Managers' Work	89
3.1 Sources of Change	89
3.2 Variability of Change	90
3.3 I.T. Involvement of Managers	91
3.4 Pace	94
3.5 Fragmentation	95
3.6 Planning and Time Horizons	96
3.7 Summary	97
4. Managers and People	98
4.1 Numbers of People	98
4.2 Skills of People	99
4.3 Management of People	102
4.4 Summary	105
5. Managers and Communication	105
5.1 Structural Issues	106
5.2 Data Issues	109
5.3 Oral Communication	111
5.4 Summary	111
6. Managers and Decision Making	111
7. Summary of I.T. Effects	113

	<u>Page</u>
<u>'HARDWEAR'</u>	117
1. The Company	117
1.1 History	117
1.2 Products	118
1.3 Organization	119
1.4 The Study	119
1.5 Summary	122
2. I.T. Implementation	122
2.1 The I.T. Culture	122
2.2 I.T. Applications	124
3. The Character of Managers' Work	131
3.1 I.T. Involvement of Managers	131
3.2 Pace	134
3.3 Fragmentation	135
3.4 Boundaries	135
3.5 Planning and Time Horizons	136
3.6 Summary	137
4. Managers and People	137
4.1 Numbers of People	137
4.2 Skills of People	140
4.3 Management of People	140
4.4 Summary	143
5. Managers and Communication	143
5.1 Structural Issues	143
5.2 Data Issues	144
5.3 Oral Communication	146
5.4 Summary	146
6. Managers and Decision Making	147
6.1 'Group' Influence	147
6.2 Rapidity of Data Handling, and Decisions	148
6.3 Decision Support	150
6.4 Summary	151
7. Summary of I.T. Effects	152

	<u>Page</u>
<u>'FASHION'</u>	157
1. The Company	157
1.1 History	157
1.2 Products	158
1.3 Organization	159
1.4 The Study	161
1.5 Summary	161
2. I.T. Implementation	161
2.1 I.T. Culture	161
2.2 I.T. Applications	162
3. The Character of Managers' Work	168
3.1 Involvement of Managers in I.T.	168
3.2 Pace	172
3.3 Fragmentation	173
3.4 Boundaries	173
3.5 Planning	175
3.6 Summary	175
4. Managers and People	176
4.1 Numbers of People	176
4.2 Skills of People	176
4.3 Management of People	177
4.4 Summary	178
5. Managers and Communication	179
5.1 Communication Issues	179
5.2 Summary	181
6. Managers and Decision Making	181
6.1 Decision Issues	181
6.2 Summary	183
7. Summary of I.T. Effects	184
 <u>'INTEGRAL'</u>	 186
1. The Company	186
1.1 History	186
1.2 Organization	188
1.3 The Study	188
1.4 Summary	190

	<u>Page</u>
2. I.T. Implementation	190
2.1 I.T. Culture	190
2.2 I.T. Applications	192
3. The Character of Managers' Work	195
3.1 I.T. Involvement of Managers	195
3.2 Pace	199
3.3 Fragmentation	200
3.4 Planning and Time Horizons	201
3.5 Summary	202
4. Managers and People	202
4.1 Numbers of People	202
4.2 Skills of People	203
4.3 People Management	205
4.4 Summary	205
5. Managers and Communication	206
5.1 Structural Issues	206
5.2 Data Issues	208
5.3 Oral Communication	209
5.4 Summary	209
6. Managers and Decision Making	210
6.1 The Decision Milieu	210
6.2 Speed of Data Handling, and Decisions	211
6.3 Summary	212
7. Summary of I.T. Effects	212
 <u>'COMPONENTS'</u>	 215
1. The Company	215
1.1 History	215
1.2 Organization	215
1.3 The Study	216
1.4 Summary	218
2. I.T. Implementation	218
3. The Character of Managers' Work	220
3.1 I.T. Involvement of Managers	220
3.2 Pace	225
3.3 Role Specification	226

	<u>Page</u>
3.4 Planning	228
3.5 Boundaries	230
3.6 Summary	230
4. Managers and People	231
4.1 Numbers of People	231
4.2 Skills of People	232
4.3 Training	234
4.4 Management of People	235
4.5 Summary	237
5. Managers and Communication	238
5.1 Structural Issues	238
5.2 Data Issues	240
5.3 Oral Communication	243
5.4 Summary	244
6. Managers and Decision Making	245
6.1 Decision Issues	245
6.2 Summary	247
7. Summary of I.T. Effects	247
 <u>CHAPTER FIVE : ANALYSIS</u>	 250
5.1 Introduction	250
5.2 Implementation of Information Technology	251
5.3 Implications for Managers	265
 <u>CHAPTER SIX : CONCLUSIONS AND REFLECTIONS</u>	 293
 <u>APPENDICES</u>	
1. Managers Interviewed	309
2. Interview Formats	314
3. Compilation of Questionnaires	326
4. Questionnaires	331
 <u>BIBLIOGRAPHY</u>	 338 - 355

LIST OF FIGURES

Page

CHAPTER ONE - None

CHAPTER TWO

2.1	Relationship between culture, structure and processes	15
2.2	Data Flow	27
2.3	Main frames, minis and micros - a perspective	29
2.4	Basic Elements of I.T.	31
2.5	Comparison of Computers : 1959/1984	32
2.6	Hardware Generations : speed and cost comparisons	33
2.7	Physical, Interpersonal and Intelligence Processes	41
2.8	Functions and Systems Activities	46
2.9	Aspects of Managers' Work	51
2.10	The Implications Framework	52

CHAPTER THREE - None

CHAPTER FOUR

'ENGINEERING'

4.1	Employees, Turnover, Profit	74
4.2	Organization and Pattern of Interviews & Questionnaires by function	76
4.3	Pattern of Interviews and Questionnaires by tier	77
4.4	Purchase Transactions	85
4.5	I.T. Involvement of Managers	91

'HARDWEAR'

4.6	Employees, Turnover, Profit	118
4.7	Organization and Pattern of Interviews & Questionnaires by function	120

	<u>Page</u>
4.8 Pattern of Interviewed Managers by function and tier	121
4.9 Pattern of Questionnaires and Interviews by tier and by function	131/2
4.10 I.T. Involvement of Managers	133
4.11 Staff Reduction in Manufacturing Function	138
4.12 Numbers of Staff Responsible to Managers	139

'FASHION'

4.13 Employees, Turnover, Profit	158
4.14 Organization	160
4.15 I.T. Involvement of Managers	168/9

'INTEGRAL'

4.16 Employees, Turnover, Profit	187
4.17 Organization	189
4.18 Pattern of Surveyed Managers	190
4.19 Pattern of interviews and Questionnaires	196
4.20 I.T. Involvement of Managers	197
4.21 Manager Responsibilities for People	203

'COMPONENTS'

4.22 Pattern of Surveyed Managers	217
4.23 I.T. Involvement of Managers	221
4.24 Qualifications of Managers	221
4.25 Manager Responsibilities for People	231

CHAPTER FIVE

5.1 "Imperatives" in I.T. Implementation	261
5.2 Paradigm of I.T. Vectors and Managers' Work	267
5.3 I.T. Tendencies for 'People' Issues	279
5.4 I.T. Tendencies for Communication	280
5.5 Comparison of I.T. Involvement	281
5.6 Accelerating Expansion of I.T. at 'Engineering'	284
5.7 I.T. Tendencies for Decision Making	289

CHAPTER SIX - none

CHAPTER ONE

INTRODUCTION

"Unfortunately, though practices related to managerial effectiveness are widespread, most are being undertaken without benefit of research-based evidence..." *Campbell et al (1970)*

CHAPTER ONE : INTRODUCTION

1.1 Preface

The principal interest of this researcher is in the education, training and development of managers.

Universally, managers are regarded as key to the fortunes of organizations, thus their development is crucial for organizational success, however framed. Effective management development, it is widely argued, hinges on understanding the actual work and contexts of managers, and these are likely to be increasingly affected by information technology (I.T.).

Hence, the motivation for this research is to improve understanding of how I.T. is influencing organizational contexts of managers and, specifically, how the work, roles and behaviours of managers are changing. Outcomes from the research could be useful both in terms of policy for management development, and in management practice.

This chapter introduces the issues and layout of the thesis.

1.2 Technology, society and work

Over the years, the nature and place of technology have been researched extensively, from two predominant perspectives: the influences of agents such as government, education, workers and management on the diffusion and use of technology; and the influences of technology on these agents. It is important at the outset to emphasise the two-way interaction between technology, (and specifically I.T.), and any other agent: each is continuously changing and producing new influences on the other. There is a dynamic fabric of causes and effects - a situation common to all social research and a fundamental reason for the difficulties of method and of understanding. The research described in this thesis focuses on a single-way influence: of I.T. on managers. Nevertheless the complexity and interactivity of the organizational fabric is present

always.

All happenings have precursors, and although public awareness of I.T. had a dramatic upturn in the late 1970s (JENKINS and SHERMAN, 1979), research interest in computers and their interplay within organizations has been ongoing for decades (LEAVITT and WHISLER, 1957; BEER, 1959; WHISLER, 1966; STEWART, 1971). As in the general case of technology and its interaction with other elements, research into computing (and later into I.T.) and its reciprocal relationships, has concentrated mainly on the influences on the diffusion of the technology, and on the effects of I.T. on selected actors, mainly shop floor workers and on control of their work. For instance, ARMSTRONG (1984) looked at technical change and reduction in life hours of labour at work, and BELL (1983) reported on the behaviour of labour in situations of technical change, and on the competitive weakness of British manufacturing. HARTMAN et al (1983) examined the use of computerized machine tools and their effects on manpower and skills utilisation in the different cultural and structural contexts of British and West German manufacturing firms, a theme further explored by BESSANT and GRUNT (1985). In fact, the literature on the management of technical change is characterised not by the impact of technical change on managers or management, the subject of this thesis, but by its prescriptions of how managers should plan, organise and control new technologies for the use of others.

But I.T. has one characteristic which both separates it quite distinctly from technologies in general, and makes it of central importance to managers. It deals with information - the quintessential stuff of organizations and management. Whereas technology has until now in the main been applied to physical processes, and therefore affected mostly shop floor workers and activities, I.T. operates on and within the information patterns and processes of organizations, and is thus at the heart and brain of management itself.

1.3 Managerial Work

Although there is a vast management literature, the nature of managerial work is still not well understood. For example CAMPBELL et al (1970), summed up their extensive literature study as follows: "Much of the business and psychological literature on the topic of managerial effectiveness is based on little more than personal experiences or opinions about 'traits' possessed by good managers, what they must do to be effective, or what the products of their effective behaviour may be ... (p.15). Unfortunately, though practices related to managerial effectiveness are widespread, most are being undertaken without benefit of research-based evidence defining the nature and effects of determiners of managerial effectiveness". (p.4). Though that was written seventeen years ago, there is little evidence in the literature that the situation has changed. It is not surprising, therefore, that the management literature is even more sparse on influences of I.T. on management work.

Here then is a paradox. It is well accepted that organizational well-being, however defined, is predominantly dependent on management, and that I.T. is likely to be a powerful influence on organizational information and decision processes - both central to management. Yet, to date, the influence of I.T. on the work, roles and behaviours of managers has received little research attention. Consequently, understanding of this interaction is not well developed, as shown by the wide ranging survey of research by FRIEDMAN (1983) undertaken for the S.S.R.C. (now E.S.R.C.).

1.4 Themes in the literature

Because of inherent qualities, described later, I.T. has wide applicability and is entering organizations in many forms, for instance on the shop floor through robotics and automation; in offices via computers, and between sites in the form of telecommunications. This versatility and ubiquity implies

effects both local in space and time, and non-direct. The latter are those extending to features distant from the site of the I.T. application, often having consequences well after the application took place. WILKINSON (1982), for instance, emphasises the learning which goes on long after a microelectronics system is introduced in manufacturing; FRIEDMAN (1985) confirms the same in data processing installations. DAWSON and McLOUGHLIN (1984) point to structural changes hierarchically distant from the applications of computer technology in freight handling.

We are thus dealing with the interactions of two complex fields: information technology, which actually comprises several interwoven technologies, and managerial work. To understand this interaction it is necessary to review, and to draw upon, a wide literature, particularly covering:

a. The nature, development, application and diffusion of technology generally, and information technology in particular. This tends to divide itself into the influence of agents on the technology, and the implications of the technology for those agents.

b. The nature of work, roles and behaviours of managers. This is set within a voluminous literature on all aspects of management and organizational studies.

c. Systems theory and practice. This is itself a large field, and often seems to be separate from, rather than a part of, the management literature.

By and large, these are often treated as separate themes, but they are strongly interactive, and must be integrated here in order to make sense of the implications of I.T. for managers.

1.5 Layout of the thesis

As mentioned earlier, there has not been a strong research emphasis on I.T. effects on managers. The work described here is undertaken as some contribution to filling this gap. However, the thesis does not pretend to be comprehensive in its coverage of I.T. applications and their effects on managerial work. Rather, the research is exploratory, and attempts to identify the change tendencies in managers' work, roles and behaviours, as I.T. increasingly enters their contexts. For reasons set out in Chapter Three, on Method, the five companies studied are all in manufacturing. Nevertheless, the main emphasis is on I.T. in office settings in a wide range of organizational functions, and covering all levels of management.

Chapter Two (Information Technology and Managers) presents an analysis of material relevant to these issues, under the following headings:

2.1 The organizational context: the complex cultural, structural and process contexts of organizations that managers deal with, and in which I.T. is being implemented.

2.2 Technology and change - the general case: the nature of the diffusion, usage and consequences of technology in general.

2.3 Information Technology: the historical development of I.T. from its precursors, and its generic characteristics.

2.4 Management processes and systems: organizational processes and systems, and specifically those considered to be managerial.

2.5 The Implications Framework: for use in acquiring data from field work and for its subsequent analysis.

Chapter Three (Research Method) describes the thinking leading to the choice of the five manufacturing companies studied, and

the interview, questionnaires and other data collection methods used.

Chapter Four (Information Technology and Managerial Work in Five Manufacturing Companies) sets out the findings of the field work in case study form.

Chapter Five (Analysis) examines and integrates thematically the data from the five companies.

Chapter Six (Conclusions and Reflections) summarises the conclusions of the research and considers their relevance to management and management development.

At the outset the main questions appeared to be:

- A. What is the character of I.T. diffusion and implementation in the companies?
- B. How is I.T. changing the general nature of managerial* work?
- C. How are specific components of managers' work, namely communication, decision making and interpersonal matters, being affected?
- D. To what extent are the implications of I.T. on managers dependent on existing management practices and cultures?

These original research questions have stimulated, and guided, hopefully in a creative way, the literature study, the field work and the subsequent analysis.

* The research focuses on the work and behaviours of managers as individual role-holders, although naturally management, the composite of these roles as a cultural, structural and process entity within the organizations, is referred to where relevant. Also, the term 'administration' is generally avoided as in U.K. industry and commerce it has connotations of lower order clerical work. 'Management' here is taken to mean the organizational executive hierarchy inclusive of supervisors.

CHAPTER TWO

INFORMATION TECHNOLOGY AND MANAGERS

"The impact of new information technology depends on where and how it is used. The wide range of application leads to a similarly wide range of effects, many of which may be in different directions..."
Sorge et al (1982)

CHAPTER TWO

INFORMATION TECHNOLOGY AND MANAGERS

Organizational contexts are highly complicated, and as the literature consistently illustrates, the diffusion, usage and implications of technology are equally so. I.T. is entering virtually all aspects of companies and is thus impinging upon key organizational processes - the work, roles and behaviours of managers. These issues are explored below under:

- 2.1 The Organizational Context
- 2.2 Technology and Change : The General Case
- 2.3 Information Technology
- 2.4 Management Processes and Systems
- 2.5 The Implications Framework

2.1 THE ORGANIZATIONAL CONTEXT

Information Technology is impacting upon managers within the immensely complex contexts of organizations. Groups of people transacting amongst themselves, and with other individuals and groups beyond their own boundaries, involve many forces - social, psychological, political, economic, technological - each continuously modifying and changing its influence on the others, and on the whole organization.

These aspects of organizations have been extensively researched for decades; the literature is huge, rich, but confusing. "The domain of organization theory is coming to resemble a weed-patch - researchers confront an almost bewildering array of variables, perspectives, and inferred prescriptions". (PFEFFER, 1982). Similarly ENGWALL (1982) wrote under the banner "Organization theory: where are you?" - "The goal of a unified organization theory has not been achieved and it seems less likely today than 70 years ago".

This section presents an analysis of the organizational context in which managers work and within which I.T. is impacting. Since I.T. comprises several technologies and applications, it is important to understand that there are a multitude of I.T. effects interacting with many, and various, organizational features.

Classification of the literature can only be arbitrary for, while there are 'schools', their definitions and boundaries, within organizational theory alone are (as PFEFFER wrote) bewildering. But the situation is even more complicated. For in order to understand the implications of I.T. for the work of managers, it is necessary to look at three terrains, which have often been treated as separate: technology, the work of managers, and systems. As introduced in Chapter One, these themes are contiguous and interactive.

Organizations will be treated here as having three predominant features: culture, structure and processes.

2.1.1 Organizational Culture

Culture is the unwritten sets of assumptions and expectations which organizational members hold, and which give meaning to their own, and others', actions. (HANDY, 1976; PETTIGREW, 1979). Recently, greater emphasis has been placed on the ways in which organizational cultures maintain themselves over time (DEAL and KENNEDY, 1982), and in relation to change (PETTIGREW et al, 1982; MINTZBERG, 1984). Naturally, there are many sub-cultures within an organization (for instance, of manual workers, research and development, or marketing), but in this thesis the interest is on the management sub-culture.

2.1.2 Organizational Structure

Structure, according to CHILD (1977) allocates people and resources to tasks, and provides mechanisms for their co-ordination, for indicating expectations to staff and for

decision taking. This description incurs difficulties, for like some other authors, CHILD includes in structure, specifications of processes. Nevertheless, structure is the relatively visible descriptions and prescriptions of the patterns of tasks, responsibilities, authority and roles. (DALTON, LAWRENCE and LORSCH, (eds) 1970).

Structure is form and defines:

- a. The number of roles and their titles (for instance, 1 Sales Director, 5 Regional Sales Managers, 26 Salespersons).
- b. The functional groupings of staff and responsibilities, that is the generic 'horizontal' divisions of a company, for instance, Marketing, Finance, Production, Personnel, and their subdivisions. Marketing might be subdivided into Advertising, Direct Sales, Technical Support, though, as we shall see, each company is unique in structuring and naming functions.
- c. The hierarchical 'vertical' responsibility patterns, the number of 'tiers' and the 'spans of command'.
- d. The tasks, responsibilities, authority and status of individual roles. The degree to which these definitions exist in any organisation varies enormously, and is itself part of that specific culture.
- e. Various committees, communication and decision patterns; again specific to each particular organization.
(LITTERER, 1965, MILLER and RICE, 1967).

(In this thesis the term 'designatory' structure is used to encompass a. to e. above).

Structural-contingency theory has probably been the dominant approach in the sociological and business school literatures, it

being assumed that an element of the organization's context, for instance, technology, produces certain structural consequences. (WOODWARD, 1965; PUGH et al, 1968). As will be shown later, this idea is confirmed: I.T. is changing organizational structures.

According to COWLING and EVANS (1985), in the U.K. there is little formal organizational design in companies: structures are based on the experience of senior managers, and on issues of head-count pressure. The relationship of structure to culture, and processes are generally not widely considered, at least in U.K. organizations. It seems that structure is decided by individuals, or groups, and is characterised by 'state' discretion. Most of the features of structure are in state A, until at a particular moment they change to state B. Exceptions to this would be the degree of definition of managers' roles and responsibilities which might alter gradually. Managers patently vary in the extent to which they will conform to any formal, or even implied, definition of their roles, or allow variation from role definition in their subordinates.

2.1.3 Organizational Processes

Processes are ongoing within the organization, and across its external boundaries, and are thus characterised by activity. They vary widely from shop floor production, for instance manual handling of products or equipment, to intellectual processes such as decision making, or interpersonal as in interviewing. Processes may be 'management' processes or 'non-management' processes dependent on levels of discretion and responsibility. The literature on all processes is abundant, and often presents them as systems, or sub-systems (for instance, BEER, 1959, 1972; THOMPSON, 1967; KAST and ROSENZWEIG, 1979).

It is quite common to describe the cluster of linked operations of a manufacturing company, (such as machining, assembly, inventory, quality and associated planning and control mechanisms) as the production system. Likewise 'information

system', or 'communication system' is usually used to mean the flows of information throughout the organization and beyond its boundaries.

While systems are usually associated with processes, which imply flows of, for instance, artefacts (the production system), money (the banking system), people (a transportation system), the same characterisation is used for data (management information system), or a complete organization, or society. In these latter more global situations, 'system' may be used to include structure or culture, as well as processes.

2.1.4 The Primacy of Management Processes

Twentieth Century civilisation is a society of organizations, and the leadership groups of old, often based on aristocracy or religion, have been replaced by managers according to DRUCKER (1982). Within all organizations there are certain prime processes which are specifically managerial in nature - setting goals, establishing, assigning and co-ordinating resources, monitoring achievement (and others). It is not part of this thesis to deal with organizational politics, but it is noteworthy that there has been, and is, an ongoing struggle for power between various actors in organizations, about control of key processes, and this is always an element in the culture specific to each organization, not least in the arena of technology. (WILKINSON, 1983). It is important to note that this struggle is not unitary opposition of management and non-management, but rather an often paradoxical amalgam of conflict and co-operation amongst a 'web of interests'. (CRESSEY and McINNES, 1980).

'Management' then is, by general agreement, the primary subset in the organization, viewed as a system. BEER sees it as "the brain of the firm"; KAST and ROSENZWEIG as one of five subsystems, the others being goals and values, structural, psychosocial and technological, all of which interconnected by the managerial subsystem.

There is also wide consensus amongst both researchers, and practitioners, that information transactions are fundamental to all processes in organizations (GALBRAITH, 1977; HAY and MAJUF, 1981). Inter-relatedness, the coupling between relevant organizational activities, is a prime function of management, and also dependent upon the quality and quantity of information transactions. Both management processes, and information transactions (the arena of I.T.) are then intimately associated with organizational competence and relative success. (It is interesting that inter-relatedness within nature, (CAPRA, 1975; RUSSELL, 1982) and within societies (WILLIAMS, 1981 and 1983), as well as within organizations, is emerging simultaneously as an important issue).

Classically, the early literature presented some sort of management principles which were thought to be universally, or at least, widely applicable. FAYOL (1916) divided management into planning, organising, motivating, co-ordinating and controlling, and he was followed along similar lines by BARNARD (1938), and BRECH (1953). Until the last few years, authors seemed compelled to classify all aspects of organizations and management into highly defined and tightly boundaried compartments. The more systems orientated approach of BEER (1959) and MILLER and RICE (1967), softened the functional boundaries and the divisions, and began to suggest management was an integrating function.

But there is another element weakening the concreteness and compartmentalised approach of management writing. While the flows of artefacts, and money in organizations, and the visible manifestations of structure, were amenable to study, the work, roles and behaviours of managers have proved almost impossible to observe and analyse unequivocally. In practice the theoretical Fayolian processes merge one with another, and often go on simultaneously. Planning for instance can be at the same time co-ordination or motivation. The more empirically-based authors, for instance, LORSCH and ALLEN, (1973), emphasise appropriateness, rather than adherence to formula. Particular

management approaches derive from, or are relevant to, specific organizational contexts. BURNS and STALKER (1961), for example, held that fast change led to 'organic', while slower change had 'mechanistic', management styles, a conclusion especially pertinent to the research here described.

2.1.5 Technology in Organizations

The effects of technology in organizations had been studied by the early management observers (TAYLOR, 1911, GANTT, 1919, GILBRETH, 1920). Originally, all work had been carried out virtually exclusively by people, using tools as appropriate, but machines have been taking over this work in an uneven manner, temporally and spatially, depending on technological invention, development, diffusion and usage. The early writers mentioned above, and others, saw machines primarily entering the production (and transport) functions; machine power and manipulative efficacy substituting for human muscle and skill. The effects therefore were principally upon manual shop floor workers. Although there were obvious concomitant changes in labour processes, floor layouts, and emphasis, the impingement on managers was peripheral. The fundamental processes in which managers took major roles remained essentially the same.

Although, WOODWARD (1958 and 1965), KHANDWALLA (1974), and others found type and degree of technology to be contingent for management features, principally structure, the research was almost exclusively looking at technology on the shop floor. Technology was being used within data handling functions in telephonic and telex communications and in punched card systems before 1950, and there were many studies of these (SHANNON, 1949, CHERRY, 1957). But it is only since 1959 that computers have been used in business and then to begin with, only in a discrete, isolated 'main frame' mode, generally dealing with high volume, low 'intelligence' processing. In contrast I.T. since the late 1970's has been entering the central realm of managers: information and communication systems and decision making. Further, this later phase of I.T. is leading to a

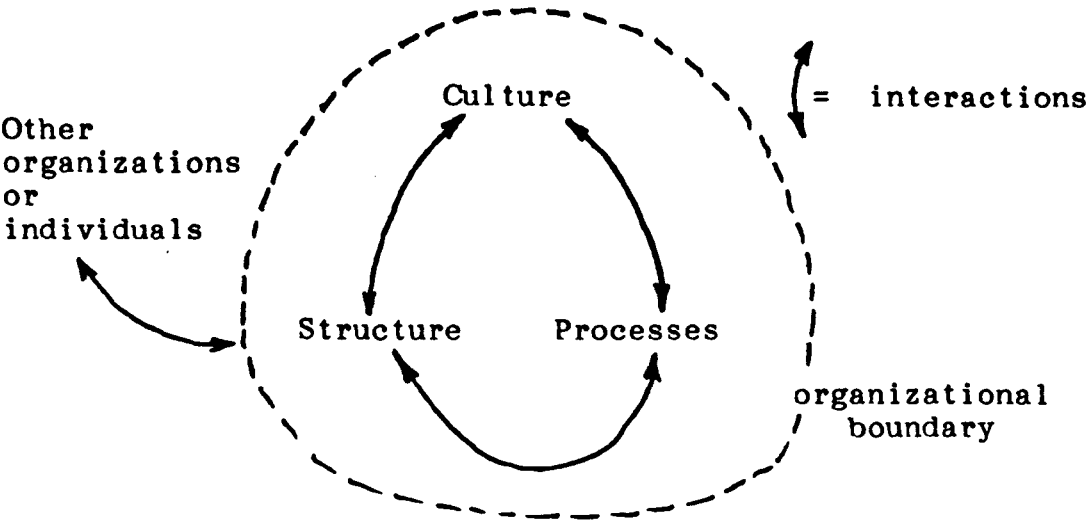
distributed network mode, and able to deal with higher levels of complexity.

To summarise, a number of themes have been described in this section:

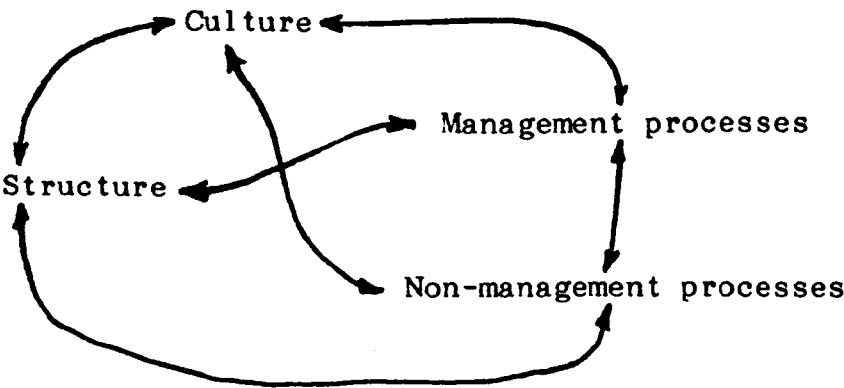
- a. Organizational culture, structure, and processes and their interaction.
- b. The idea that processes, and to an extent, everything, in organizations, can be described in system terms.
- c. The idea that management is a primary sub-system.
- d. The fundamentality of information transactions, in organizational processes and to management.
- e. The importance of inter-relatedness in organizational activities, and the centrality of both management work, and information transactions. Management is holistic and integrating and uses information in this key role.
- f. Until the late 1970's, although technology was important within organizations, it had only tangential effects on managers.
- g. Information Technology is now entering the central realm of managers: information and communication systems, and decision making.

The relationships between culture, structure, processes, and I.T. are depicted in Figure 2.1, below. Note that processes can be 'management' or 'non-management' and both are influenced by I.T.

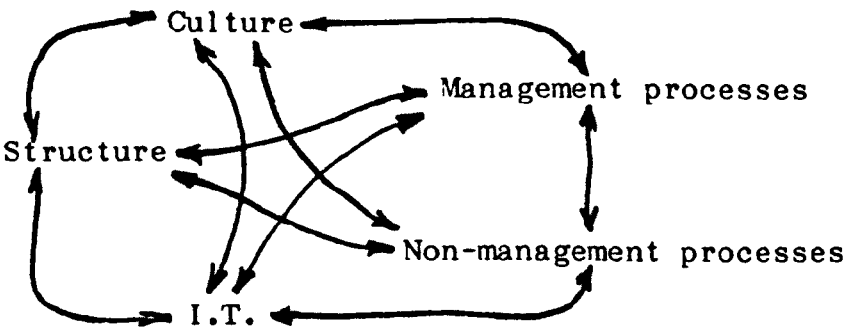
Figure 2.1 Relationship between culture, structure and processes



Processes can be seen as either management or non-management:



I.T. is entering both non-management, and management processes:



2.2 TECHNOLOGY AND CHANGE : THE GENERAL CASE

Before looking at I.T., it is useful to consider the general case of technology and change in organizations. As SCHUMPETER (1954) pointed out: "Long before the industrial revolution, people realised the obvious fact that machinery often displaces labor ... Governments and writers worried about this and labor groups and citizens' guilds fought against machinery, the more so because immediate effects of this kind are concentrated in time and place, whereas the long run effects on general wealth are much less visible in the short run and much less easy to trace to the machine".

2.2.1 Technological Influences

The long history of technological applications has brought change to organizations, workers, management, and society, and has been the focus of attention of economic historians such as TOYNBEE (1908), CUNNINGHAM (1903) and the WEBBS (1932). Nevertheless, according to MATHIAS in MACDONALD et al (Eds), (1983), most attention was given to the consequences - and usually adverse consequences - on society generally, rather than on the specific implications in organizations. Within the literature there has tended to be an heroic tradition of ascribing great and specific importance to particular inventors and to their inventions (the Watt engine, Hargreaves' spinning jenny, are examples), whereas recent studies (SCHMOCKLER, 1966; PARKER, 1972; ROSENBERG, 1976, WILLIAMS, 1983, and RAY, 1983, have revealed processes of innovation and diffusion to be much more gradual, evolutionary and anonymous. This is an important conclusion to bear in mind in consideration of I.T. and its implications within organizations.

Britain's relative industrial decline has been a cause of concern for a century or more, and many explanations have been forthcoming, most of which have included the lacklustre U.K. performance in developing and using technologies. (HOBSBAWN, 1968, LEWIS, 1978, PAVITT, 1980, and WIENER, 1981). In contrast

it has been widely accepted that in scientific research Britain has been pre-eminent (though IRVINE and MARTIN (1984) have recently suggested that U.K. research has been less efficacious for the national economy than was commonly believed). The vast literature on this issue establishes the complexity, and the interdependence, of the many variables associated with technology and Britain's economic development. It is clear that the problems are not so much specifically scientific, or even technological, but multi-factored and human. (SWANN, 1983). Much of this literature deals with technical, economic, government policy, labour market and societal issues. BESSANT et al, 1981; BELL, 1983; WILLIAMS, 1983; LIFF, 1983).

Typically the research considers how the diffusion of innovations is influenced by various social, economic, or policy, components, or how technology affects such elements as productivity, wage differentials, employment, in various market sectors, or industries. It is worth repeating that in this research tradition there is relatively little looking at the effects of technology on managers, or on managements. Further, although management is patently the vital agency in organisation, the influence of management on technology diffusion and usage has also received scarce treatment.

Science has always been allowed to be conceptual, even though much practice is clearly involved, but technology has a stronger connotation of doing, and is usually a synonym for machinery. Yet it is quite possible for technology to involve no machines at all. SCHUMPETER, (1939), described technological change as "any 'doing things differently' in the realm of economic life", and certainly in every technological change there is much that is conceptual, organisational, economic, and managerial.

It is plain then that changes in technology, broadly defined, have had profound effects on societies at several levels, both in its immediate impact, and in its gradual consequences. (MACDONALD, 1983). Although, taking a historical perspective, it is now easy to see, for instance, the effects on transport,

of the steamship, and of the aeroplane, it seems to be extremely difficult to understand what is actually happening at the time.

2.2.2 Technology and Work

Within organizations from TAYLOR (1911) on, changes in the formalisation of labour work, and later 'mechanisation' (BRIGHT, 1958), altered physical layouts, labour groupings and certain control functions of management. Technology was being applied almost exclusively in production functions, and most directly affected factors related to that function. (CHILD and MANSFIELD, 1972). WOODWARD (1965) conceptualized technology in production into three types: small batch, large batch, and continuous process, and based her analysis therefore on periodicity of the production process. She found that several organizational characteristics were related to these types, such as the ratios of managers to total personnel, of clerical and administrative staff to manual workers, the labour cost as a proportion of turnover, and the span of control of the chief executives.

The Aston Studies (HICKSON, 1969; PUGH and HICKSON, 1976) however, failed to replicate Woodward's results on the importance of technology. Indeed, in spite of the volume of work in this field, there are few clear conclusions: " ... the discrepancies ... seem to be at least as great as the commonalities". (CHILD and MANSFIELD, 1972, p. 389). Inconsistency within the literature may be caused by the lack of common conceptual definition and different levels of analysis (GERWIN, 1979). Various authors adopt different conceptualizations of technology - for instance PERROW (1967) sees technology as work done on raw materials, a characterisation linking technology essentially with the production function common to many writers before around 1970, for instance, WOODWARD (1958).

Indeed the majority of research, and writing, about organizations, specifically in relation to the implications of

technology, took place with this kind of characterisation, certainly before what is now termed information technology was introduced on a significant scale.

Also, predominantly, researchers focussed on organizational (and usually structural), and labour process implications, and relatively little attention was given to effects on managers. Following the work of SORGE et-al (1983), MANSFIELD (in PIERCY, (Ed) 1984) suggests a number of trends widely observed in work organizations, and typical of the writings in this arena including increases in:

- a. Mechanisation of work leading to replacement of human effort by machines and technical systems.
- b. Automation of work leading to the replacement of human thinking and control by machines and technical systems.
- c. Capital intensity leading to a partial replacement of labour costs by investment in machines and technical systems, and more obviously by a shift in the balance of expenditure, thus decreasing the percentage spent on wages and salaries.
- d. Division of labour between different functional activities. This is seen both between different personnel involved directly in the production process, and between production activities and control, support, and other staff activities.
- e. Polarisation of skills leading to a very sharp and significant gap in the skills, experience and qualifications between largely semi-skilled operatives and the frequently highly technically skilled design, control and maintenance personnel.
- f. Centralisation of decision making relating to operating decisions.
- g. Bureaucratisation of production with increasing use of plans and schedules.

MANSFIELD suggests that these trends can be explained in terms of dealing with task accomplishment, and cost control, or

reduction, and that maintaining managerial control is largely a secondary problem, the solution to which is instrumental in finding solutions to the other two issues.

In the general case then, technology, a broad mix of machines, concepts and techniques, has diffused in a largely gradual, evolutionary, anonymous, and patchy fashion. And as we shall see later, the same is true for I.T. Although in retrospect the implications of technological change seem obvious to authors, they are complex, often contradictory, and almost incomprehensible at the time the technological change is occurring. That technology is an important sub-system, of organizations is well understood (KAST and ROSENZWEIG, 1979), but agreement within the literature about its implications for organizations only holds at general levels, and has mostly not focussed on implications for managers.

2.3 INFORMATION TECHNOLOGY

Information technology follows the general trends of technology but is postulated here to be a special case because it is dealing with information, and because it is directly entering the managerial realm. In many ways information technology is only a sub-set of the general case of technology, though because it is related to the quintessential stuff of society, information, it is argued widely that it has a special nature and importance.

A long evaluation of artefacts, processes and ideas characterise the development of I.T: signal fires, flags, the abacus, stagecoach mail, maps, codes, mathematics - all significant in human history. (SINGER, 1954; DUMMER, 1977; STRANDH, 1979; MADDISON, 1983). And since the Nineteenth Century there had been an acceleration in electrical and electronic developments, which led to a burgeoning after, say, 1930, of a matrix of data processing concepts and hardware: the telephone, radio, radar, sonar, machine coding, punched card machines, and computers. (TOOTHILL, 1965).

2.3.1 Early Days in Computing

The first computers operated as discreet, central, rather isolated machines, and although able to manipulate large amounts of relatively simple data quickly, were not integrated distinctly into the organization as a whole. As these 'mainframe' computers came into common use in the 1950's and 1960's, predictions were widespread that the effects would be "revolutionary" for organizational structures and processes. LEAVITT and WHISLER (1957) predicted a return to centralised decision making and a considerable reduction in middle-management staff, as decision making moved upward and computers took over the information processing roles of such staff. WHISLER (1966) found five major effects:

- a. Decision making can be rationalized, with a greater access to quantified information.
- b. Enlarged scope of decisions since more information is available.
- c. Level at which decisions are made may change.
- d. Rhythm of planning decisions may change.
- e. Decisions made by man-machine, and not just man-man systems.

Rosemary STEWART (1971), in her well-known studies of computers in several companies (four of which were in manufacturing) concluded:

- a. Effects on management varied from one case to another.
- b. The type of computer application influenced the nature of the effects on management.
- c. The effects on management varied within the same type of application.
- d. The effects of computer applications on management were not inevitable.
- e. During the computerisation process the most common effect is an increased workload for managers.
- f. Managers (in one case) appeared to make more use of the

system with time.

- g. The most striking effect was the way managers were stimulated by the use of computers to think about their policies and activities.
- h. Organizationally the main effect was the creation of a computer department.
- i. There was a marked decrease in clerical staff, and sometimes an elimination of one tier.
- j. An increase in formalisation of procedures took place.
- k. There was no evidence of increased centralisation.
- l. Levels at which decisions were taken may be changed.
- m. Time horizons may change.
- n. Power balance between departments may change.
- o. Department boundaries may be weakened.

An American study at about the same time, (CHURCHILL et al, 1969), based on interviews with users, managers and computer department management in several companies, concluded that the information systems literature presented a far more advanced picture than that which actually existed, (a point worth keeping in mind in a field well noted for hyperbole). The researchers found there was little or no impact on higher levels of management.

These pieces of research are illustrative of much of the literature before the late 1970's. They describe centralised, isolated, 'un-distributed' computing, usually with a single computer under the control of an 'Electronic Data Processing' department. The researchers varied widely in their analyses, and their predictions, from the WHISTLER model of revolutionary change, to the STEWART, and CHURCHILL, conclusions which were more grounded, and tentative. Significantly it is difficult to find any anticipation in the management literature before 1978, of the dramatic developments in microelectronics which were about to become public. For instance, it is given but a few lines in the report of a major colloquium on "the changing expectations of society in the next thirty years", held at Windsor Castle in 1979 by the American Assembly of Collegiate

Foundation for Management Development. In the report of an international seminar in La Hulpe, Belgium, February 1978, "Management Education in the 1980's" there is no mention of information technology - in fact the word computer occurs only once!

2.3.2 The Arrival of I.T.

Almost certainly the public awakening - and government reaction to it - sprang from the BBC TV 'Horizon' programme "Now The Chips Are Down" in the Spring of 1979, and its text which appeared in the 'Listener' on 6th April that year.

Notwithstanding its long evolution, suddenly I.T. became recognised by the major nations as a considerable factor in contemporary economic and social dynamics. In fact, throughout the Western World there began a period of intense interest in I.T. with an outpouring of literature and media comment, much of it predicting substantial changes in society, in organizations, and in work. (NORA and MINC, 1978; JENKINS and SHERMAN, 1979; BARRON and CURNOW, 1979; BESSANT, 1981; FRIEDRICHS and SCHAFF, 1982; GERSHUNY and MILES, 1983). Japan, U.S.A., Europe and the U.K. quickly set up large scale research projects into the technology and its applications.

In spite of the predictions, since the late 1970's, "It is apparent that the available evidence is too scant for commentators to find common ground". (LAND in PIERCY, 1984). SORGE et al (1982): "A great number of studies have been carried out, which deal with microelectronics as a general phenomenon and try to determine economic and social consequences. However, no reliable assessment of the impact has been possible".

Two schools of thought about I.T. are articulated within the literature. The first might be termed the 'rationalists' for they see I.T. as part of the continuing, and inevitable substitution of machines, albeit electronic now, rather than

mechanical as in the past, for people, and so derive directly from the TAYLOR tradition. This viewpoint is often termed 'deterministic' in the literature. The school might be divided into optimists and pessimists. The optimists believe that the technology is neutral (COOLEY, 1980), or favourable (BAKER, 1980; EVANS, 1979), and will result in improved social, and economic consequences, and especially more effective management (KEARNEY, 1984). The pessimists believe the process will inevitably result in an increase in social controls, degradation of work, and reduction in jobs (BRAVERMAN, 1974; BARRON and CURNOW, 1979; JENKINS and SHERMAN, 1979).

The second school takes a contingency approach (BESSANT and GRUNT, 1985; LAND, 1984) and is probably well summed up by SORGE et al (1982): "The impact of new information technology depends on where and how it is used. The wide range of application leads to a similarly wide range of effects, many of which may be in different directions. We would argue ... that the consistent references to microelectronics having 'effects' is not helpful".

One question then for the field work was to what extent were the implications of I.T. for managers contingent on the character of their situations, and their organizational context.

2.3.3 The Character of I.T.

The definition of I.T. adopted by UNESCO is "the scientific, technological and engineering disciplines and the management techniques used in information handling and processing; their applications; computers and their interaction with men and machines; and associated social, economic and cultural matters (RAITT, 1982). A more grounded description was given by Kenneth BAKER, the first U.K. Minister of State for Industry and Information Technology in 1982: "The use of computers, microelectronics and telecommunications to help us produce, obtain and send information in the form of pictures, words or numbers, more reliably, quickly and economically".

Computer Generations

Computer technology has moved through a number of 'generations' categorised by hardware characteristics as follows:

1st Generation (1940's and 1950's)

Thermionic valve based central processing unit (CPU), rotating memory, undeveloped software; used mainly in scientific work, and later in accounting, invoicing and payroll applications, at the same time as Hollerith punched card machines.

2nd Generation (Late 1950's to mid 1960's)

Transistors in CPU, magnetic core memory; software compilers and languages introduced; basically batch processors, computers become common in large organizations.

3rd Generation (Mid 1960's to mid 1970's)

Large Scale Integrated Circuits (LSI) for CPU's; Developing real time processing, and on-line applications by remote terminals. Programming, routine and skilled. Later, semi-conductor technology for main memory, and time sharing using 'virtual memory'.

4th Generation (Mid 1970's to date)

Very Large Scale Integrated Circuits (VLSI). Increased power for size; very large fast semi-conductor memories; on-line applications for large data bases. I.T. emerges: Convergence with telecommunications; microcomputers; very fast hardware cost reduction; new programming languages. User-friendliness.

5th Generation (1990? to ?)

Higher scale component integration - 1 micron, and later sub-micron geometrics, (10,000 gates/mm² , or 500,000 gates per chip); parallel computer architectures; improved languages; improved man-machine interfaces, including early speech recognition. Intelligent-Knowledge-Based-Systems increasingly used.

(LUCAS, 1982; MOTO-OKA, 1982; DANZIN, 1983; ALVEY, 1985; Potterdam Conference Papers, 1984; ENNALS and COTTERELL, 1985).

Electronic Data Processing

While it would not be appropriate in this work to include detailed descriptions of office or shop floor technologies, understanding of the basic I.T. equipment and applications is essential to the subsequent discussion. Definitions of both 'data', and 'information' abound, but there is a consensus that data are 'raw', whilst information is derived from it, has meaning to the recipient, and is of value, or perceived value, in decision making. However, in reality the difference between data and information, is not always clear, and the words are used almost interchangeably. Note also that the value of information is dependent upon a range of factors. Again, the elements within 'intelligence' (used in the military sense) processes vary according to author, but here will be classified as:

Data Capture

Data Storage

Data Transmission

Data Analysis

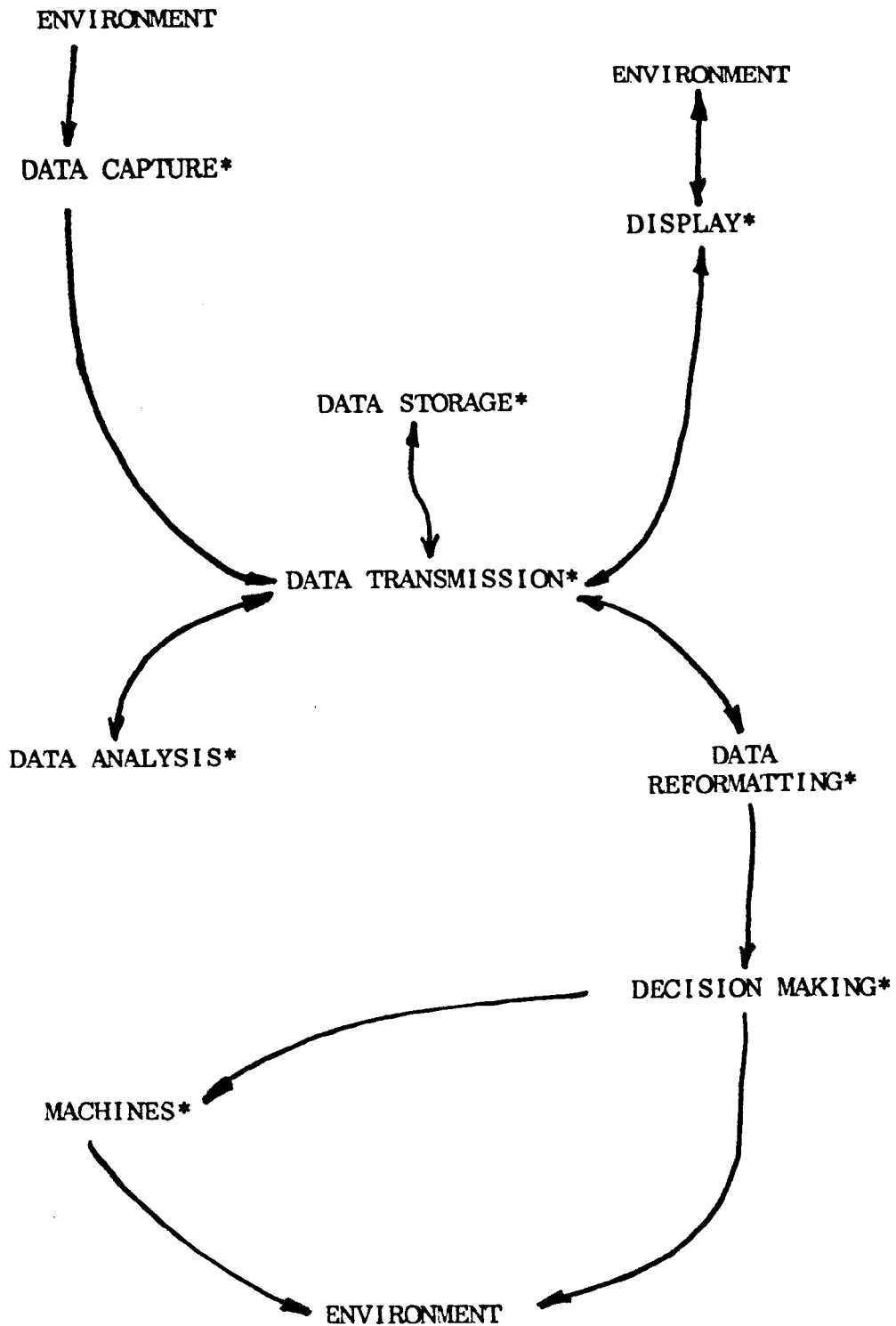
Data Reformatting

Data Display (on paper, visual or audio)

Decision making (machine, or machine/human, or human)

These elements may be combined in many ways, but commonly are as shown in Figure 2.2.

Figure 2.2 Data Flow



* All these could be P.M.M. = Paper-Manual-Mental or could be I.T.-driven.

I.T. then is usually some combination of telecommunication and computing, and may also include 'application equipment' such as robotics. Telecommunications facilities generally do not change the information content between input and output, and include telephone, radio, telex, electronic mail (e-mail), electronic message handling, facsimile (fax), teleconferencing, audio or audiographic conferencing, and data networking (for digital transmission of computer data and images). (BAKER, 1980; DOSWELL, 1983). Telecommunications are now essentially computer based, for the timing, routing and formatting of messages and data.

In most computing facilities, changes in information content may be inherent in the process, though this returns to the meanings of information, and data. Computers will here be treated as 'black boxes', but the classification in Figure 2.3 is a guide.

Where I.T. is used in control engineering, in automation and in robotics, there is always a point at which the 'data management' is translated into physical activity through equipment. Opinions vary as to whether this physical equipment should be regarded as part of I.T. This is not an important issue in this thesis.

There is a general consensus in the literature that I.T. has generic characteristics which make it different, not only from 'computing' but also from all previous technologies. It is postulated throughout this work that the character of I.T. influences many aspects of the organization and these are changing managerial work and roles. These generic characteristics are now to be analysed and presented here. In essence I.T. consists of combinations of several technologies all based on electronics, or opti-electronic hardware, incorporating systems principles, being used in many varied applications. The effects of I.T. in organizations derive from an amalgam of some

CATEGORY	COST	WORD SIZE (BITS)	MAIN MEMORY	SECONDARY MEMORY	FLOATING POINT OPER- ATIONS PER SECOND	SIMULT. USERS	SPACE REQ'D	TOTAL SUPPORT STAFF	SOME MANUFACTUR- ERS
<u>SUPERCOMPUTER</u>	$\pounds 10^6$ $\pounds 10^5$	128	10+ Mbytes	1 Gbyte	10^8 10^6	1 or a few Many 10^2 or a few	Suite	Dozens Dozens	Cray, Cyber IBM, Honeywell, NCR, ICL.
<u>SUPERMINI</u>	$\pounds 10^4$	32	A few Mbytes	100 Mbytes	Many 10^3 s	250 20-250 8	Large room Small	10 10 2	DEC, HP, GEC, Data General, Harris, Prime, Norsk Data.
<u>MICRO</u>	$\pounds 10^3$	32	0.5 Mbytes 100+ Kbytes	10 Mbytes	Some 10^3 s	4	On or under Desk	1 or 2	IBM, DEC, HP, Olivetti NCR, Apple ICL, ACT, Amstrad, Atari, Commodore, Sinclair, Tandy, Casio
<u>PROGRAMMABLE CALCULATOR</u>	$\pounds 10^2$	8	30 Kbytes	100 Kbytes	A few 10^6	1	Desk	0	
<u>POCKET CALCULATOR</u>	$\pounds 20$ $\pounds 5$	16	1 Kbyte 4 Kbytes	0	1	1 1 1	Hand Hand Hand	0 0 0	

Kbyte = 1,000 bytes
 Mbyte = 1,000,000 bytes
 Gbyte = 1,000,000,000 Bytes

FIG. 2.3 MAINFRAMES, MINIS & MICROS - A PERSPECTIVE (WALKER, 1986)

Prices are changing quickly; prices also depend on specification, and what peripheral equipment is included. Note also that all operating characteristics are improving, i.e. speed, word bit size, main memory; thus any classification is out of date within three years.

Figure 2.3

or all of its characteristics dependent upon applications. This is important: the implications of I.T. are not due to a single characteristic such as processing speed, though in certain applications this is a prime factor, but to an array of characteristics. As will be shown later, I.T. has a field-effect - interacting with the total system that is the organization, and creating change in culture, structure and processes, but in ways which are contingent upon these three components of the system.

Generic Characteristics

a. Combination

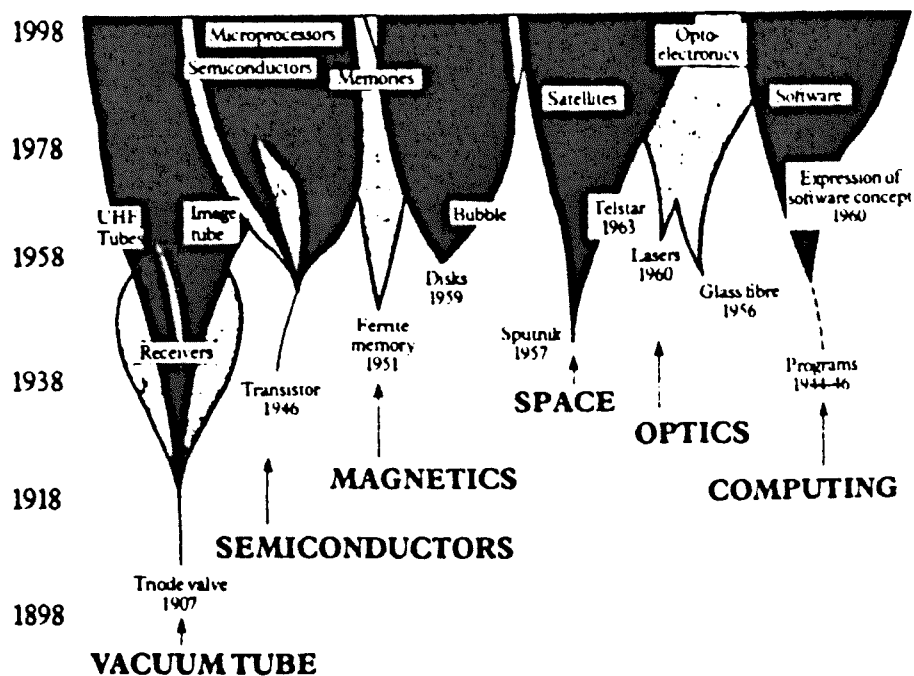
I.T. is a phrase which has been given to combinations of several technologies, the principal ones being computing, telecommunications, microelectronic, and software engineering. In addition there are other technologies - automation, robotics, opto-electronics, lasers and satellites, which are also dependent upon, or associated with I.T. (See Figure 2.4).

Underlying these combinations are the practices of information handling, and the facilitating concept that all data can be converted to a two stage (binary) form especially suited to electronics, or opto-electronics. This applies to all data sensed directly from the 'physical' world, for instance chemical, or biological measurements, and all data from the 'social' world, such as numbers of people, hours worked, money spent, costs, items scrapped. These latter may be directly sensed, or may be inputted from people via terminals, or paper. (Naturally the physical and social environments are contiguous).

Once data are in binary form reformatting is intrinsically easy, as is transmission - both at very high speeds. The combinations of technologies are thus possible because of the underlying common information concepts. Whereas previous technologies applied to specific and limited areas - for instance weaving, coal mining, metal machining, or transport, I.T. is a broad, facilitating technology, likely to be rooted in all future

technological developments. (LARGE, 1980 and 1984; LAURIE, 1983). Figure 2.4 illustrates the basic elements of I.T. (From DANZIN in OTWAY and PELTU, 1983, p. 22).

Figure 2.4 Basic elements of I.T. (From DANZIN, 1983)



b. Development Rapidity

I.T. has been characterised by a rapidity of development far in excess of any previous technology. WATSON (1985) gives the following comparison:

Figure 2.5Comparison of Computers: 1959/1984

	1959	1984
MACHINE	PEGASUS	ICL
Status	Medium Performance per cost	Personal Computer Low Performance
Price (1984 Equivalent) Control	£750,000	£2,000
Processor	375 packages	1 card
Working Store	1 Kbytes	250 Kbytes
Permanent Store	Magnetic drums 42K + Magnetic tape 100K	5.25" disc = 500K
Typical Environment	Air-conditioned Computer room	Desk top Anywhere
Performance	3K instructions per second	1000K instructions per second
Power Consumption	13.5KW	.280KW
Weight	900 Kg	16 Kg
Price/byte of Working Store	£750,000	£8
Price/K instructions per second	£250,000	£2
Price/K immediate permanent store	£17,825	£4

LUCAS (1982, pp. 112 and 113) gives the following indication of developments:

Figure 2.6 Hardware Generations: Speed and Cost
Comparisons (From LUCAS, 1982)

Generation	Access Time Per Digit Microsecs	Binary Add Time Microsecs	2 Digit Add per hour Millions	Cost Per Million 2 Digit adds £
1st (1950s)	10	700	51.4	35
2nd (1961)	4.5	88	409	5.56
3rd (1965)	.63	12	2,400	1.25
3.5 (1971)	.19	4.2	6,792	.54
4th (1979)	.11	3.4	8,372	.13

DANZIN (1983) suggests that between 1960 and 1980 there has been a 10,000-fold improvement in key aspects of I.T. such as volume and weight per performance, operating speed, price reduction and energy consumption.

Military applications are continuing to be important for I.T. This stimulates huge government expenditure in the field. In addition the commercial market for I.T. is vast, continuing to grow quickly and motivating research and development funding. The Japanese "Fifth Generation" (MOTO OKA, 1982), the U.K. "Alvey" (ALVEY, 1985), the European "Esprit", "Fast" (FAST, 1984), and several U.S. research and development programmes are consequences of the competitive I.T. scene. The literature of the history of technology shows that contemporary views of particular inventions or developments are varied, and often wrong. Whether the present extremely fast pace of I.T. development will be seen historically as a special phenomenon of these technologies remains to be seen. However, as will be remarked upon later, I.T. has certainly developed and diffused rapidly, and technical development seems certain to continue at a fast pace.

c. Universality

Deriving from common underlying information concepts and practices, I.T. appears to have extremely wide applications and is currently being used in organizations in these forms (though applications are not discrete - a particular application may include elements from more than one form):

- i. On the 'shop floor' in manufacturing associated with and usually inherent in automation, robots, 'flexible-manufacturing systems', and 'computer-integrated manufacturing'. Applications may include combinations of automatic tool selection, component and sub-assembly movement and machining, (MARSH, 1984), and/or robotics (TOWILL, 1984), all with many management implications (VOSS, 1986).
- ii. In continuous production processes, which may be in manufacturing, but are mainly elsewhere. Starting in 1957, most early computer control systems were in the petrochemical, the steel, and power generation industries - (because of their common character of high level of fixed assets and 24 hour operation) and subsequently spread to paper, cement and glassmaking. Computers are used to monitor product and equipment status, to provide information for decision making, either by the equipment (for altering equipment states) or by management. (CONSTABLE, 1971).
- iii. In a wide variety of 'administrative' functions, usually office-based, such as inventory control, purchasing, finance and marketing which, until perhaps 20 years ago, were virtually all paper-manual-mental (P.M.M.) processes. (BARRAS and SWANN, 1983; LONG, 1984).
- iv. In various forms of telecommunication between people, offices, and sites, including internationally, allowing data to be transmitted rapidly, often in seconds, with optical fibres, for instance, capable of carrying over

1,000 million bits per second. The literature emphasises the convergence of telecommunications and computing technologies (DANZIN, 1983; BAKER, 1980).

- v. In systems which aid, or substitute for, management decision making, varying from 'decision support systems' (offering a range of data base interrogation, and/or modelling) (LUCAS, 1982) up to 'Intelligent-Knowledge-Based-Systems, (IKBS or 'Expert Systems'), which potentially offer powerful decision aid, for instance in diagnostic situations (FEIGENBAUM, 1980).

This universality of I.T. is likely to influence all organizations, and all elements in organizations. (BELL, 1973; PORAT, 1976; BANNON et al, 1982; SENKER, 1984).

d. Economic Advantage

The prices of I.T. products have been falling rapidly. According to WATSON (1985) the cost/performance ratio has improved 100,000,000 times in the 25 years from 1959 to 1984. The reduction in hardware costs has been 40% per year during the 1970's (LARGE, 1984). Software is not considered to be falling in price, indeed according to some authors (for instance DANZIN (1982) is growing in cost. However, consideration of software costs must take into account the increasing complexity of I.T. applications, and the increasing 'user-friendliness' of software, both of which increase cost of software, but may still produce overall economic advantages within the application. Also, much research into 'fully automated' programming is underway, which will almost certainly begin to reduce software costs. (ALVEY, 1986). Certainly, the proportion of costs absorbed by software has been rising: in 1955 software represented less than 20% of total system costs, by 1970 the split was 50-50, and by 1980 software was 80% of all costs (TRICKER, 1982). Nevertheless, there is wide consensus that overall economics are assisting the I.T. diffusion.

e. Size of Equipment

Early computers consisted of racks of thermionic valves (a lamp-like device of 40 to 60cc in volume), perhaps 4,000 of them, housed in air-conditioned cabinets filling a large room (MADDISON, 1983). There has been a steady size reduction of components using LSI (Large Scale Integration) and VLSI (Very Large Scale Integration), and 100,000 gates per chip are now common. Research towards 500,000 gates/chip is well advanced (ALVEY, 1985). Computer overall sizes have reduced proportionately and as WATSON shows a 16Kg machine in 1984 was much more powerful and faster than the 900Kg 'computer room' machine of 1959. The personal, desk-top, carryable, micro-computer is the direct consequences of size reduction, but size advantages also accrue in many 'shop floor' applications.

f. Speed of Operation

Fundamental to micro-electronics and opto-electronic is speed of operation which is measured in thousand-millionths of a second, nanoseconds, or million-millionths of a second, picoseconds. (At these speeds the contents of the Bible could be scanned in 1.5 seconds (LARGE, 1984). The increase in processing speed is shown in Figure 2.6 (from LUCAS, p. 243).

Processing speeds are expected to continue to increase using higher component densities, architectural parallelism, and higher efficiency software (SIMONS, 1985), particularly because of the competitive commercial and military pressures like those of the Strategic Defence Initiative.

Speed is important in organizational settings in two ways: firstly, in manipulating and reformatting data - millions of times faster than paper-manual-mental arrangements, and secondly, in data transmissions throughout the organization and beyond.

g. Data Accessibility

Because of data transmission speeds, the relative cheapness of terminals, and the decreasing cost of connectibility, the number

of access points to data networks is increasing in organizations. In early computer applications the processing machine was "isolated" from the organization, and transacted via intermediate input and output arrangements, for instance by punched card. The few terminals were located adjacent to the machine and used solely by Data Processing operators, a cadre special to that function. Batch entry was predominant, that is data was converted from paper into an input medium for the computer, and subsequently entered into the machine. Batch entry together with the scarcity of terminals outside the province of the Management Information Systems (M.I.S.) function implied difficulty of access for most staff or managers, with control of M.I.S. in the hands of a special group of managers and operators.

As terminals became more widely distributed in the organization a much greater population is able to transact with data networks. Data accessibility is increasing as will be discussed in the fieldwork chapter (Chapter Four).

h. System Specificity

A computer system is specifically programmed, and will repeatedly and faithfully follow the required procedures on cue. At lower levels of complexity, as with wages calculation procedures, or robot guidance, there is high system specificity.

Many processes in organizations (for instance inventory control) have previously either been entirely paper-manual-mental (P.M.M.), or partly P.M.M., and partly machine systematic. As these "intermediate complexity" processes are increasingly computerised, all inputs and relationships have to be reduced to numerical values. The processes themselves have to be analysed, understood, and transformed into computer programs, and this forces a higher system specificity. Data and procedures become 'harder' and more precise.

The combinations of these generic characteristics provide the technical capabilities of I.T. in data handling and in

communication, and also condition the diffusion and usage of the technologies. In the following section the issue of I.T. applications in management processes and systems is considered.

2.4 MANAGEMENT PROCESSES, AND SYSTEMS

2.4.1 Organizational processes

As was argued in Section 2.1, within any organization, a large number of processes are ongoing, relating to people, data, artefacts and money. A three-fold classification of such processes is used here:

a. Physical Processes

In these, physical energy is expended in changing or moving physical entities, as in machining or assembly on the shop floor. Originally all work was of this kind, requiring human muscle power and energy, or animal power, for instance in agriculture, mining and manufacturing. Historically, the whole focus of developments of tools and machines, and later, automation, has been in this arena, and not surprisingly the bulk of the literature on technology and labour process is about physical work (discussed in a previous section). While technological applications were patently changing labour process, and thus issues of labour control, there were also consequences for management.

In BRIGHT's (1958) studies, as process uncertainty or ambiguity was reduced, there was a movement toward integrating equipment, standardizing operations and production sequence changes, all management issues. Ford combined the idea of interchangeable parts, and line assembly, according to ABERNATHY and TOWNSEND (1975), both concepts of process organization. Numerous changes in management practices resulted.

It would be too facile to deduce that the technologies of mechanisation produced only peripheral effects for managers' work, for the literature documents important process changes in

which managers must have had a central interest. Nevertheless, there is little in the literature which records such mechanisation as changing the nature of managers' work. Mechanisation, without electronic controls (before, say, 1960), was characterised by its relative lack of coupling with associated processes. In contradistinction, systems with computer controls (Flexible-Manufacturing Systems, and Computer-Integrated-Manufacturing) are closely coupled, not only with associated physical processes, but with the 'intelligence' system of the organization (GERWIN and TARONDEAU, 1981; BOODY and BUCHANAN, 1982).

b. Intelligence Processes

The word 'intelligence' is used here in the sense common to the military, implying data capture, formatting, analysis, transmission, display and associated decision making. Before (say) 1900 these processes would have been essentially paper-manual-mental (P.M.M.) arrangements varying in degree and extent of specification and formality. The more specified and formalised data, and data procedures, have been commonly termed the Management Information Systems (M.I.S.), though according to DAVIS (1974), there is no agreement on the name, or its exact subject area. Some intelligence processes, for instance accounting records, have been formalised and systematised for decades, and were the earliest to be dealt with by machine, firstly using punched cards, and more recently using computers (AARON, 1969). On the other hand, some intelligence processes are highly unstructured, difficult to specify, informal, and transmitted by text, or orally. In general, the structure and specification of intelligence processes is highest at the lowest organizational levels, and decreases as the hierarchy is ascended.

c. Interpersonal Processes

Transactions between people involve complex social, psychological and spiritual issues, and are the subject of an immense literature ranging from considerations of the personality (MASLOW, 1945; EYSENCK, 1965), to interpersonal and

group activities (HERTZBERG, 1966; ARGYLE, 1967; SCHEIN, 1969).

Interpersonal transactions naturally are dealing with information, and part of this may be contributing to the unstructured intelligence processes mentioned above. But in addition there are interpersonal processes within difficult-to-define transactions such as motivation, negotiation, counselling, and consultation, which may not specifically be involved in intelligence activities.

These three sets of processes (physical, intelligence and interpersonal) are interwoven to form the total system which is the organization. The work within these processes is divided between people, and machines, while the total work of people is divided between manual workers; non-manual, non-management personnel; and managers (DOUBLEDAY et al, 1983). However, definitions of, and boundaries between, these roles are uncertain, and as the research in this thesis will show, becoming more so.

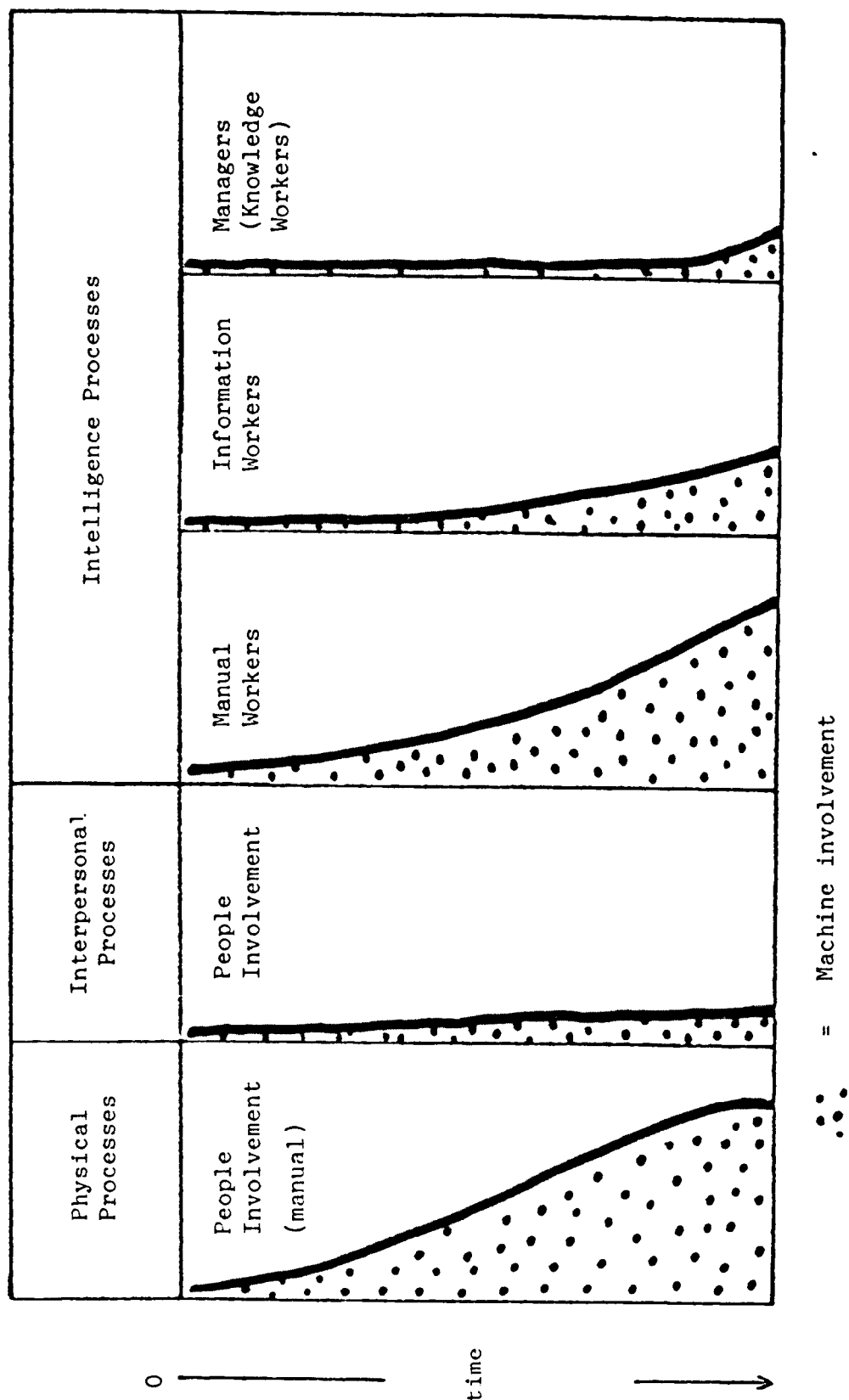
Information Technology is entering:

- i. The Management-Information-System (M.I.S.) part of intelligence processes;
- ii. Intelligence processes associated with machine-accomplished physical processes, for instance systems on the shop floor. This is control engineering; and
- iii. Communications between people (which is a component of interpersonal processes).

While extensions of I.T. into these three activities will have implications for all people in organizations, consideration here is focussed on the effects on the work and roles of managers.

An attempt to convey these ideas pictorially is shown in Figure 2.7.

Figure 2.7 Physical, Interpersonal and Intelligence Processes



MENZIES (1981, and 1982) distinguishes between 'information workers' who are involved in routine entry, storage and transmission of information, for instance, secretaries, typists and clerks, and 'knowledge workers' - the managers and professionals - who utilise and analyse, information. A similar distinction is drawn by WYNNE (in OTWAY and PELTU, 1983), between those who relate passively to information (he terms these 'administrators') and those who perform, create, act on or with information - often the managers. Until recently the main import of office automation has been to facilitate current office based operations, and thus influences have been mainly on information workers. According to LONG (1984) a new phase of I.T. applications is beginning, which will directly influence knowledge workers. There is a parallel here with the application of automation on the (manufacturing) shop floor, which for thirty years mainly affected manual workers, but is now having direct effects on supervisors and managers (DAWSON and McLOUHLIN, 1984; BESSANT, in WINCH, 1983).

2.4.2. Managers' Work

The jobs of managers are combinations of intelligence and interpersonal processes, and there are many relevant studies (CARLSON, 1951; DALTON, 1959; HEMPHILL, 1960; SAYLES, 1964; STEWART, 1967, and 1976; CAMPBELL et al, 1970; and MINTZBERG, 1973; YUKL and NEMEROFF, 1979; HOUSE and DESSLER, 1985). STEWART sums up the situation: "We still know very little, as many writers have pointed out, about managerial work in practice. The main lesson that can be drawn from the various studies ... is that management is a much less tidy, less organised, and less easily defined activity than that traditionally presented by management writers, or in job descriptions". DANIEL (1985), after looking at many studies, pronounces: "little agreement on a standard taxonomy of management behaviour". Most of the literature emphasises the methodological problems of studying managerial work, and this is taken up later in Chapter Three, on method.

Rosemary STEWART'S seminal works demonstrated the variability of management activity, contingent as it is on a host of influences. Fragmentation, fleeting personal contacts, lack of routines, attention switching, were identified as common characteristics though the demands of particular jobs in terms of relationships, work patterns, uncertainties, exposure (the extent to which mistakes could be associated with an individual) and demands on private life, were the main focus in her later text (1976).

In similar studies of managerial work, McCALL, et al (1977), found: that managers work long hours; have busy, fragmented, jobs containing much variety, and brief episodes; that the work is predominantly oral; that information is the core of the job; and that managers do not have an accurate picture of how they spend their time.

The work by MINTZBERG (1973) is still regarded as one of the best treatments of managerial work. Mintzberg deduces a number of characteristics of management activity viz:

1. Much work at unrelenting pace.
2. Activity characterised by brevity, variety and fragmentation.
3. Preference for live action.
4. Attraction to verbal media.
5. The manager operates in a network of communication and contacts.

He suggests that managers use ten roles:

a. The Interpersonal Roles

As figurehead i.e. acting as a symbol of authority.

As leader i.e. using charismatic or hierarchical power.

As liaison i.e. maintaining a web of relationships.

b. The Informational Roles

As monitor - continually seeking information.

As disseminator i.e. sending information from outside his unit into and around his unit.

As spokesman i.e. transmitting information out of his unit.

c. The Decision Roles

As entrepreneur i.e. acting as initiator and designer of controlled change.

As disturbance handler i.e. dealing with involuntary situations and change.

As resource allocator i.e. overseeing the system by which resources are allocated.

As negotiator i.e. acting in non-routine negotiations with individuals or other units.

According to MINTZBERG, then, managers move from role to role contingent upon situations, in a more-or-less reactive manner at the operational level. But he hints that although to observers, managers' work seems highly unstructured, there may be higher order 'mental programmes' limiting and controlling decision making, prioritisation and so on. MINTZBERG, as STEWART, is interested in:

- a. the character of managers' work
- b. 'interpersonal roles' - people issues
- c. 'informational roles', and
- d. 'decisional roles'.

And these themes occur repeatedly in the literature, though the treatment is diverse. As described earlier interpersonal, and intelligence, processes are highly interwoven, both involve information, and both are set within the cultural and structural context. The manager is thus embedded within two contiguous, and continually interacting sets of processes, each of which can be regarded as a system:

- * The people - interpersonal system, and
- * the intelligence system.

(GORRY and SCOTT-MORTON, (1971) used a similar approach, while SIMON (1965), and other authors have been concerned with the degree of specification in intelligence processes, especially in decision making.

Both these systems are dynamic and responsive to a host of forces, one of which is the 'field effect' of information technology. Deriving from the MINTZBERG and STEWART traditions, and incorporating the 'system' themes of BEER, MILLER and RICE, and GALBRAITH, a four-fold framework is adopted for the field work in the material presented in Chapter Four, as follows:

- a. The character of managers' work;
- b. Managers and people - interpersonal roles;
- c. Managers and communication - informational roles, and
- d. Managers and decision making - decision roles.

This choice of framework is further discussed in Chapter Three on Research Method.

2.4.3 I.T. and the 'Intelligence' System

I.T. is having most impact within the intelligence system and therefore that is discussed here in more detail. HEAD (1967) classifies management information systems by level in the hierarchy:

Level 1: M.I.S. for strategic and policy planning and decision making.

Level 2: M.I.S. for tactical planning and decision making.

Level 3: M.I.S. for operational planning, decision making and control.

Level 4: Transaction processing and enquiry response.

To an extent this follows ANTHONY (1965) who suggested three types of decisions:

Strategic planning - the process of deciding on objectives and means of their achievement.

Managerial control decisions ensuring efficient and effective resource use.

Operational control decisions ensuring efficient and effective completion of tasks.

DAVIS (1974) uses this format in relation to typical 'functions' of organizations:

Figure 2.8 Functions and Systems Activities (From DAVIS, 1974, p.215).

SYSTEMS ACTIVITIES	FUNCTIONS						
	M A R K E T I N G	P R O D U C T I O N	L O G I S T I C S	P E R S O N N E L	F A I C N A O N C N E T I N G & N G	I P N R F O C R E M S A S T I N G N	T M O A P N A N E M E N T
1. Strategic Planning							
2. Management Control							
3. Operational Control							
4. Transaction Processing							

Each function has a characteristic quantity and quality of systems activities which conditions the development of I.T. use in that function.

All intelligence processes, including decision making, were originally 'paper-manual-mental' and increasingly are being influenced by I.T. There are a number of 'stage' hypotheses describing the various types of I.T. diffusion (see for example, GIBSON and NOLAN (1974); NOLAN (1979); MEYER (1982); HIRSHHEIM (1983)). The key aspect of these hypotheses is that organizations take time to learn about and adjust to new technologies, and they go through various stages, at different rates in office technology, computing and telecommunication applications. Thus a mix of technologies in various stages of development and usage can be found in any organization (McFARLAN

and McKENNEY, 1983). Each organization can be considered to be on its unique I.T. 'trajectory' according to NOLAN (1979) divided into six phases. Computers, he claims, are first used on large volume, highly repetitive, highly defined, low complexity tasks using a single, discrete, isolated machine with limited data entry and retrieval, mostly Level 4 in Figure 2.8. Electronic Data Processing (E.D.P.) is then applied serially to decreasing volume, increasing complexity, less easily defined tasks, moving up the hierarchy, (though there has been inconclusive testing of NOLAN's stages by LUCAS and SUTTON, 1979; and by DRURY, 1983). Nevertheless, as will be illustrated from the cases later, the exact pattern of applications of I.T. and the pace of implementation, is unique to each organization, and contingent upon the culture, and management emphasis.

NOLAN suggests that at first the principal force acting to introduce I.T. into P.M.M. processes is cost saving, usually implying reduced labour cost. In general, low complexity processes (Levels 3 and 4 above), typified by payroll, order processing and accounts payable, were performed by large numbers of relatively unskilled office-based personnel, and thus the potential for cost saving was large. However, as the organization is traversed upward, intelligence processes become more complex, less specifiable, less repetitive, and any particular processes are performed by relatively small numbers of people, often managers. Thus the scope for cost savings decrease, and the orientation turns towards potential value-generation. That is to gain some competitive advantage (other than reducing cost). HEDBERG (1980) suggests that in the earlier cost-savings phase, existing P.M.M. arrangements were replaced with no intention to change the organization. Impacts were largely unforeseen, often dysfunctional, and surprised both designers, and users. Later, systems were more carefully designed to avoid organizational change. It is only at a third stage that systems designers attempt to use the technology to shape an organization's structure so as to increase effectiveness, and most U.K. organizations were (according to

HEDBERG) not yet in that stage in 1980. LAND (in PIERCY, 1984) concludes that even in companies with thirty years experience of computers, there was no evidence that system designers or users looked beyond more efficient operation of the units in question. He agrees therefore that companies had not entered HEDBERG's stage 3.

As will emerge later from analysis of the case studies the implementation and effects of I.T. in companies are extremely difficult to classify. NOLAN's 'cost saving' and 'value generation' phases, and HEDBERG's reference to degree, and logic, of systems planning, can only be regarded as useful guiding concepts. Nevertheless, entry of I.T. into control systems associated with shop floor operations, and into office based transaction processing (Level 4 of Figure 2.8) does produce effects on structure and culture, and thus on the work of managers. The cost saving, and thus productivity increasing phase, has certainly reduced numbers of personnel in the cases studied, with resulting implications for the personnel roles of individual managers, and for the overall personnel functions of the organizations.

In studying information systems GALBRAITH (1973) couples the uncertainty of tasks and the amount of information transaction needed during task execution. He defined uncertainty as the difference between the amounts of information required to perform the task, and the amounts of information possessed by segments of the organization relevant to that task. He suggests that organizational forms are actually variations in the strategy of organizations to deal with uncertainty. According to GALBRAITH the simplest way of co-ordinating independent tasks is by specification of activities/behaviours in advance of the execution by rules, codes or programmes. But obviously coding or programming can only be used in predictable situations, and this becomes the limiting factor, as argued by MARCH and SIMON (1958). GALBRAITH suggests that there is a dynamic trade-off amongst five solutions to deal with the unpredictability, and the overloading of management channels of communication and

information handling. The five possible solutions are:

- a. increasing delegation, which calls for increasing the professional competence, and authority of lower level personnel;
- b. investment in information systems;
- c. creation of lateral communication paths;
- d. creation of self-contained tasks, and
- e. sustaining slack resources, that is resources above the actual need for the task.

I.T. is fundamental to at least two of these solutions, b. and c.

These several aspects of managers' work and the influences of I.T. on them are brought together in the next section.

2.5 THE IMPLICATIONS FRAMEWORK

Deriving from this analysis of the literature on management processes, and systems, a simple framework was developed of possible interactions of I.T. and managers' work, and roles, and is presented here. The literature makes clear that managers, a prime sub-set of the organizational system, are carrying out key work and roles, of which information processing, and communications, are central. Although Information Technology is often hyped by the hardware and software suppliers, it is certainly offering increasingly powerful, fast, accessible, and low cost facilities for central managerial functions.

In practice, as has been argued above, managers are dealing with a complex interweave of many elements. Indeed this is one reason for the expressed continuing difficulties in studying and analysing managers' work. Researchers have commonly resorted to narrowing their attention to specific components of that work such as decision making (CYERT and MARCH, 1963; HELLER, 1971); problem solving (KEMPNER and TREGOE, 1965); leadership (FIELDER, 1967; ADAIR, 1968), and ideologies (ANTHONY, 1986), and

naturally valuable material, and insight, have emerged. However, invariably difficulties are encountered in isolating and focussing on, separate managerial activities: it seems no mutually exclusive elements exist - each conditions and flows into the others. There is, nevertheless, a broad consensus that people, communication, information and decision making, are crucial. In addition, there has been, and continues to be, considerable interest in the 'general character' of the work, for instance degree of fragmentation, brevity of episodes, attention switching, and oral communication (CARLSON, 1951; STEWART, 1967; MINTZBERG, 1973; McCALL, 1977). These traditions are followed in this thesis in choosing four 'operational' dimensions, of managers' work:

- a. The Character of the Managers' Work;
- b. Managers and People;
- c. Managers and Communications; and
- d. Managers and Decision Making.

These do not represent separate, mutually-exclusive work, roles or functions as might be described by the four sectors in Figure 2.9a, but are four aspects - indivisible, interactive, and simultaneously occurring, perhaps better illustrated by Figure 2.9b.

Within these four broad dimensions of managers' work there are many features which contribute to its overall character, and some of these features, for instance 'boundary issues', may be relevant to more than one dimension. In fact, in the same way that these operational dimensions are interactive and indivisible, the features are likewise: they are equally difficult to separate and identify. The classification shown below and used later, in the case study descriptions and

analysis, are therefore arbitrary, but have been chosen to offer a realistic and practical view of managers' work.

Figure 2.9 Aspects of Managers' Work

Figure 2.9a

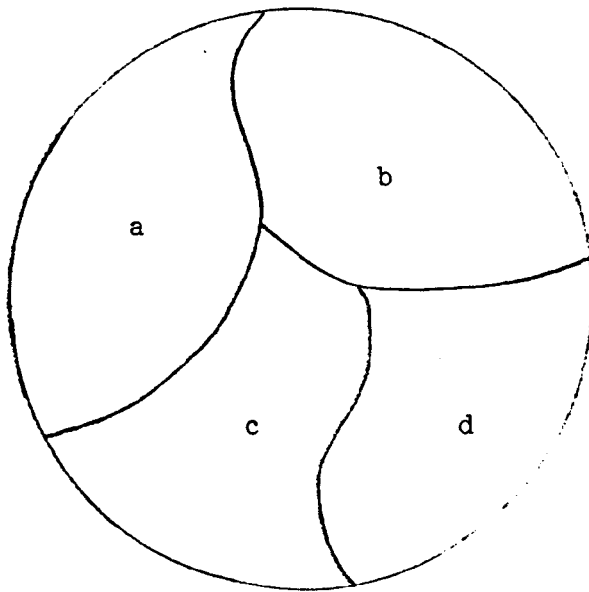
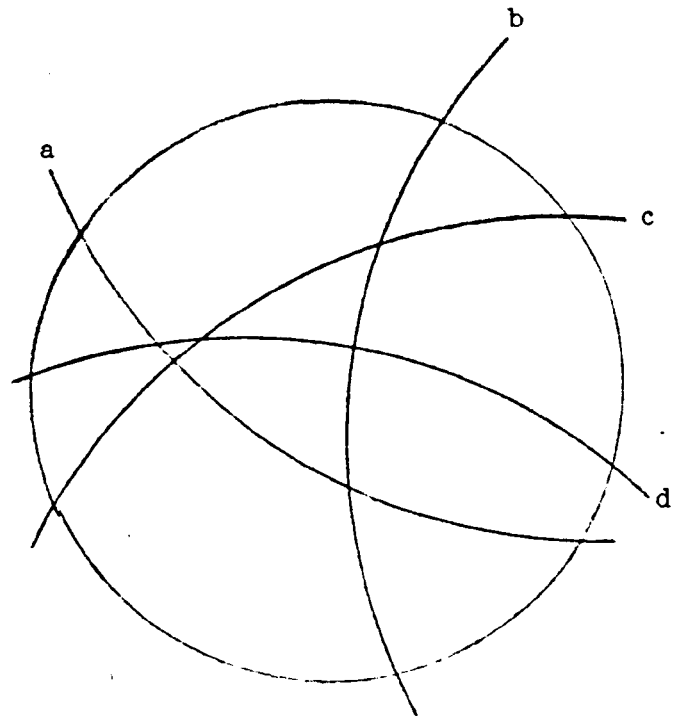


Figure 2.9b



The characteristics of I.T. (discussed in Section 2.2) which may be influencing managers' work are considered to be:

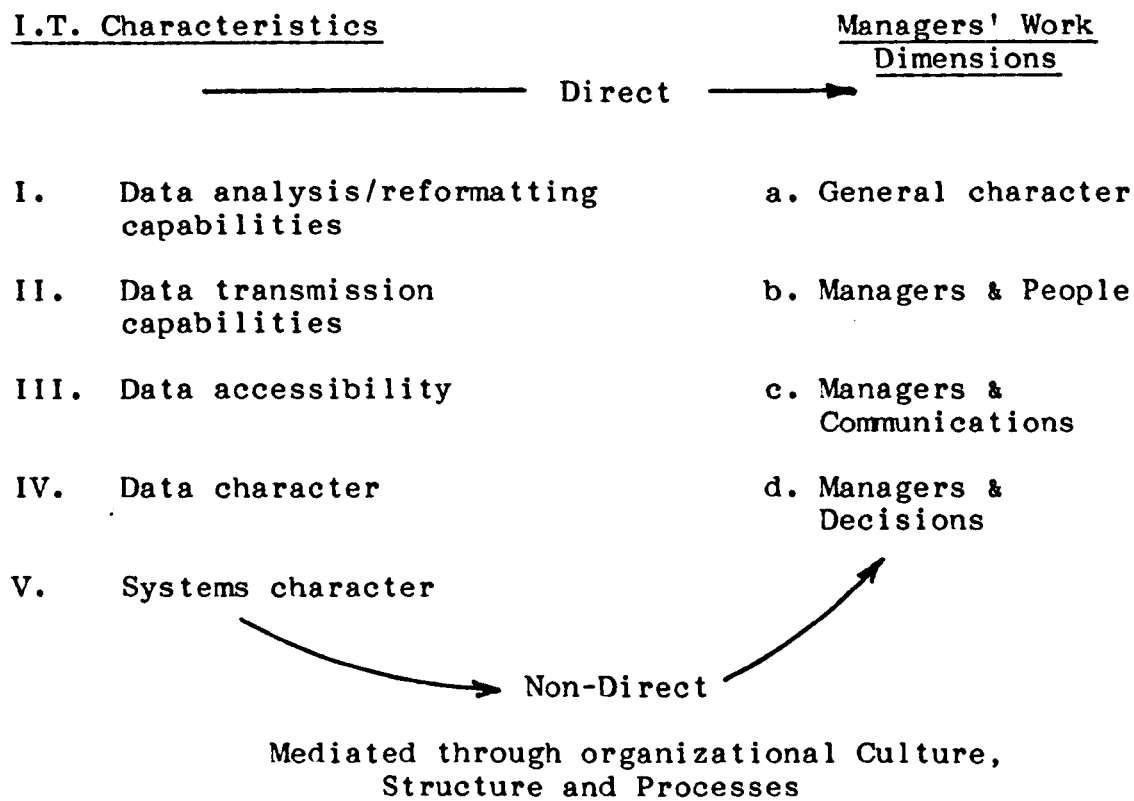
- i. Data analysis/informatting capabilities;
- ii. Data transmission capabilities;
- iii. Data accessibility;
- iv. Data character (timeliness, comprehensibility, relevance), and
- v. Systems character.

However, as with the four operational dimensions of managers' work, the effects of these I.T. characteristics are also difficult to separate, and identify. Some influences of I.T. on

mediated through organizational culture or structure, or through non-management processes. An example of this mediation is the changes in the 'people' aspects of a manager's role brought about by reduction in numbers of staff and the changes in staff skills, both associated with automation, and often at locations distant from that manager.

Although it was impossible to treat the above five I.T. characteristics as discrete features, the simple framework below (2.10) was used to structure the method and fieldwork undertaken for this thesis.

Figure 2.10 The Implications Framework



CHAPTER THREE

RESEARCH METHOD

"There are neither good or bad methods, but only methods that are more or less effective under particular circumstances in reaching objectives on the way to a distant goal." *Homans (1949)*

CHAPTER THREE : RESEARCH METHOD

3.1 The Methodological Debate

That research has contributed hugely to human progress needs no emphasis; nor that method has been the subject of vast debate. Even in relatively tightly bounded research areas where experimentation can be well defined and repeatable, there are doubts about method. WRIGHT MILLS (1959) quotes a Nobel Prize physicist, Polykarp Kusch: "There is no scientific method and what is called by that name can be outlined for only quite simple problems". Indeed even in this realm of physics, universally regarded as using highly objective and rigorous methodology, great problems exist both of acquiring valid data and in its interpretation. As BOHR (1934) puts it: "An independent reality in the ordinary physical sense can be ascribed neither to the phenomena nor to the agencies of observation". BRIGHTMAN, another Nobel Prize physicist, quoted by WRIGHT MILLS says: "There is no scientific method as such but the vital feature of the scientists' procedure has been merely to do his utmost with his mind, no hands barred".

It is no surprise that in the social sciences where the canvas is replete with open-ended issues, and where the political, social and psychological objectivity of the observer can never be unbiased, there has been continuous, and often acrimonious, debate about method. "At any given moment, of course, 'social science' consists of what recognized social scientists are doing - but all of them are by no means doing the same thing, in fact not even the same sort of thing. Social science is also what social scientists of the past have done - but different students choose to construct and to recall different traditions in their disciplines" as WRIGHT MILLS (1959) puts it, in offering his "each his own methodologist" theme. He suggests that the correct methodological and theoretical approach cannot be known in advance: it is necessary to develop "imagination", and a sense of craft, to interpret the factual significance of the theories, and the theoretical significance of the facts.

HOMANS (1949) advises a similar approach: "People who write about methodology often forget that it is a matter of strategy, not of morals. There are neither good or bad methods, but only methods that are more or less effective under particular circumstances in reaching objectives on the way to a distant goal". SMITH (1975) further stresses the need for "methodological imagination".

That sociological research in practice is very different from the descriptions found in (even classic) text books is commonly illustrated in the literature (see GOULDNER, 1967; PLATT, 1976; BELL and NEWBY, 1977). In his 'Enter Plato' (1967), GOULDNER discusses 'method versus methodolatory' and warns that it is easy for reason to become 'methodolatorous' compulsively preoccupied with a method of knowing, which it exalts ritualistically and quite apart from a serious appraisal of its success in producing knowledge".

Much of this realistic writing on doing social research advises a pragmatic approach, taking advantage of the situations offered and using such methods as will yield some contribution to the research process. This is, of course, not to say that the individual methods should be prosecuted with anything less than the highest rigour. What is being recommended (WEBB et al, 1966) is a "multiple operationalism, a collection of methods combined to avoid sharing weaknesses". DENZIN (1970) calls this "triangulation", and BESSANT (1979) suggests that "multiple methods can take a variety of forms: using insider and outsider perspectives, long and short term studies, operating simultaneously at different levels and locations, using historical and current data sources etc". This is the basis, he says, of a "contingency methodology" where choice of technique can be related to the research situation.

3.2 Studying Managers

Studying managers appears to be especially difficult for their jobs are set within the complex political, social and

psychological context of an organization needing a deep experience of that organization to be aware of, let alone understand. Further, as described in Chapter Two, all the evidence is that managers' work is composed of brief, fragmented, fast moving episodes, and that orality is prime - all difficult to observe, to recall, to document and to analyse. Researching the work of managers inevitably follows the general traditions of social science methods, namely use of documents, observation, interviews and questionnaires, of various kinds and in various combinations. Published, and unpublished documents, such as correspondence, provide indispensable data, particularly in understanding the history of an organization. "Pas de documents, pas d'histoire" of LANGLOIS and SEIGNOBOS in 1898, is still true.

Material published by companies is slanted toward the anticipated readership, which may be customers in the case of sales literature, employees for internal journals, or shareholders and the public at large for 'annual reports'. While each of these sets of documentation in the cases to follow yielded useful data, awareness of possible 'halos' was critical. According to the WEBB's (1932) the most satisfactory type of documents are those technically known as records, which they define as "intended to convey instructions regarding a transaction, or to aid the memory of the persons involved in the transaction". For the organizations to be described later in this study, records of financial accounts, of numbers of people employed, and of organizational structures were used and appeared to have good reliability, when checked against interview material.

Personal diaries are a reputable source of data according to the literature ("We are safe in saying personal life-records ... constitute the perfect type of sociological material" (THOMAS and ZNANIECKI, 1919); "Autobiography is the highest and most instructive form in which the understanding of life comes before us" (HODGES, 1944, quoting DILTHEY). But personal diaries are rather different from the self-observation and self-recording

used extensively by CARLSON (1951) and STEWART (1967). The latter are often limited by the pressure of management time to two to four weeks duration, and require a strong discipline that cannot be sustained easily over long periods given the fragmented nature of managers' work. In my experience, over many years of using self-recording methods, managers have much greater difficulties in using diaries than has been claimed in the literature. Other systems of self-study and self-recording, such as 'job behaviour episodes' (DUBIN and SPRAY, 1964; O'NEILL and KUBANY, 1959) have been used, but suffer similar drawbacks to diaries: responsibility for accuracy and continuity lies with the participant.

HOMANS (1949) suggests that "some social scientists will do any mad thing rather than study men at first hand in their natural surroundings". While there is wide acknowledgement of the necessity and efficacy of direct observation, there are also many dilemmas in its utilisation, and controversies in its utility. Firstly, there is the longstanding argument about the effect of the observer, on the observed, (already referred to in the realm of physics). Unobtrusive measures, the "anthropological method", in which the observer lives within the culture, remaining 'invisible', is a powerful tool (SAYLES, 1964; BELL and ROBERTS, 1964). But here researchers must understand and interpret their observations often without the benefit of cross-referencing (triangulation), must support their findings by anecdote rather than more systematic methods, and cannot replicate their work. However, undoubtedly the insights into specific, and usually narrow, slices of society, or of an organization, which have derived from this method are invaluable, for instance in the classic "Men Who Manage", of DALTON (1959).

In contrast, obtrusive measures are now recognised as having intervention effects on the observed situation. In the "HAWTHORNE" studies these effects became overwhelming; the fact of being observed became enormously more important to the workers than the experimental physical changes being studied

(URWICK and BRECH, 1947). Nevertheless, again, such methods have been often and usefully used. The greatest disadvantage of observation lies in the amounts of researcher time involved, and the narrow sample which often results. Because of my familiarity with all five companies before and during the field work there is a degree of observation, albeit relatively minor, in my work here.

As MADGE (1978) has it: "The interview - and its half-brother, the questionnaire - is popularly regarded as the method par excellence of social science". After all, as social scientists are interested in people, if they want to discover something about a person, surely the best way is to ask him. It turns out, as with all methods in the social sciences, that it is not that easy - there are several dimensions along which the interview varies. An important scale is that of richness versus precision - how to choose between an approach providing richness of material, and an approach offering confirmable exactitude. COHEN and TAYLOR in "Talking about Prison Blues" (in BELL and NEWBY, 1977) describe their initial rambling informality, hoping that saturation would eventually allow useful themes and dimensions of experience to surface. It became clear that their notes resisted such structuring: "The range of topics was too great, the levels of analysis too varied, the differences within even so apparently homogeneous a group were impossible to comprehend". Accordingly these researchers moved toward a somewhat more structured approach.

The degree of structure is again a sensitive dimension. It is now widely accepted that the interviewee is strongly cued by the definitions of the field inherent in the questions, and for that matter the various subtle, and not so subtle, ways in which the researcher emphasises certain parameters. (See, for example, ROSENTHAL and ROSNOW, 1970). There is also the associated problem of having a frame of reference which has utility to the research, and also makes sense to the interviewees. As Steven SMITH writes in his unpublished Ph.D. thesis (1985): "It was not that the questions were inappropriate, rather that my

respondent did not describe his work in the order I had expected". SMITH abandoned his questions and adopted a 'prompt list' which proved, for him, a satisfactory solution. McCALL, et al, (1977) argue that the most serious problem in studying managers is the development of descriptively accurate, unambiguous and comprehensive categories for classifying activities and suggest that this will always be elusive.

As ZWEIG (1948) points out: "You must already know quite a lot before you can put the right kind of questions in the right way".

The use of questionnaires has received much attention, particularly in recent years during which public opinion surveys on nearly everything are considered essential. As with interviews a central problem is what to ask, and how. HODGSON et al (1965): "To construct questionnaires, we had to know the salient dimensions of the situation we were studying. It took a year of field work to find them out, and by that time we were already obtaining so much data that questionnaires would have been of no 'incremental value'.

Reading the literature's catalogue of difficulties of obtaining and understanding data in the social science field, and particularly in studying managers, confirms the immense problem posed in learning almost anything of value, which is reliable. MINTZBERG (1973) examines, and criticizes, all the methods: although it seems the simplest way of finding out what managers do is to ask them, the results, he says, are disappointing. "To ask a manager what he does is to make him the researcher - he is expected to translate complex reality into meaningful abstraction". MINTZBERG considers there is no evidence that managers can do this effectively: in fact, there is ample evidence that managers are poor estimators of their own activities.

In spite of these difficulties, all the methods continue to be used, and continue to yield useful data.

3.3 Method for this Research

In this work because of the author's long term knowledge of the companies and the relative ease of access which this would allow, and the time available, it was decided to use a combination of interviews and the collection of published (including newspaper articles on aspects of the companies) and unpublished material. After 90% of the interviews were completed it was decided to add a questionnaire procedure, to gather certain data, and to extend the survey beyond the interviewed group. In addition, as mentioned earlier, company visits were used to observe managers and non-managers going about their tasks.

A schema of the three major components of organizations, and their possible interactions with I.T., was created at the outset, guided by the original research questions introduced at the end of Chapter One, and the literature studies.

- a. Structural components - numbers of staff, numbers of kinds of staff, hierarchical tiers, functional demarcations, structural complexity.
- b. Process components - data movements, decision making, data ownership, communication, planning and control, time horizons.
- c. Management culture components - attitudes regarding technology, effectiveness, training, visibility and priority of strategy, etc.

From this schema and drawing on the literature and on my own experience, a set of hypotheses were created, and these follow:

a. Structural Relevance

H-1 - that the number of people reporting to any manager is decreasing.

H-2 - that the proportion of professionals and skilled people in the subordinate group is increasing.

b. Process Relevance

H-3 - that the responsibility of any manager for data and for artefacts is increasing.

H-4 - that the technical, i.e. related to machines, data and systems, components of any manager's role is increasing.

H-5 - that managers are increasingly using electronic data and message handling.

H-6 - that managerial activities concerned with integration and function boundary crossing are increasing.

H-7 - that there is a diminution in the manager's greater access to data relative to permitted access of other role-holders.

H-8 - that the data progress chasing activities of managers are increasing.

H-9 - that planning is increasing and controlling is decreasing in the roles of managers.

H-10 - that I.T. is producing local effects and concomitant effects distant from points of application.

H-11 - that the I.T. system is carrying out increasingly higher "intelligence" organizational processes previously

carried out by people.

H-12 - that organizational specificity in terms of data, timing and systems is increasing.

c. Culture Relevance

H-13 - that the difference between management and non-management roles in terms of access is decreasing.

H-14 - that management roles are becoming more team-like and less hierarchical.

H-15 - that organizational roles in general are becoming less routinised and call for more initiative taking, and that management roles are becoming less definable in terms of routines.

H-16 - that managers' apparent activity rate is decreasing and reflective activities are increasing.

H-17 - that as I.T. permeates an organization all roles gain more managerial activities, and the distinction between management and non-management roles decreases.

From the schema, and these hypotheses, a set of interview questions was derived and discussed with several researchers working in the field, and who all advised using a semi-structured approach. The questions were therefore composed in that format, and piloted with six managers (see Format 2 at Appendix 2). It was immediately apparent that the questions were inhibiting flow from managers, and following the comments of SMITH (1985) mentioned earlier, a more open form of the questions was formulated (see Format 3 at Appendix 2), as well as 'prompt lists'. With experience, the author learned to reshuffle the order of the questions, and to allow the interviewee to convey his own emphasis, and priorities, to the subjects discussed, as the interview proceeded. This approach

felt more real and usually, but not always, produced a stream of relevant, useful and reliable data. Usually managers welcomed the opportunity to explore their roles, and often the problem lay in closing the interview, rather than in getting the process going. My thirty years experience of management, and at least fifteen years knowledge of each of the investigated companies, were considered to be of major importance in obtaining reliable and valuable data in interviews, which naturally depended on credibility in terms of management understanding. I had made at least ten visits to the plant and offices of each company over these years, had observed factory and office processes and had detailed discussions with many managers. The fieldwork interviews took place between July 1984 and January 1986.

Use of a tape recorder was considered but rejected because of its possible inhibiting character.

A simple five-tone format was chosen for the questionnaire, which took 20 to 30 minutes to complete. Drawing upon the interview material (then virtually complete), managers were asked to compare their present activities with those five years previously. The questionnaire was appraised by four Ph.D. researchers, amended, and piloted with a group of middle managers, with whom subsequent discussions were held on understandability of the questions, and again amended.

Part of the questionnaire was designed to allow classification of managers into groups:

- A - specialist I.T. manager (for instance, Management Information Services, computer department, or an exclusively I.T. orientated role in a functional department - such as a computer program manager in an engineering department).
- B/C - "More I.T. involved" manager (considerable use of I.T. equipment, software, and involvement in systems design or modification). It was originally intended to separate

managers in the 'middle-ground' into a greater (B) and a lesser (C) degree of I.T. involvement. However, this proved impossible. The indicator B/C is therefore used in the text as a reminder of the range and variety of this group.

- D - "Less I.T. involved manager" (little use of I.T. equipment or software, and little involvement in systems design or modification). Managers in this category were easily identified.

The discrimination into these categories was based on:

- a. Whether Visual Display Unit (V.D.U.) in own office.
- b. Whether Personal Computer (P.C.) in own office.
- c. Number of computer packages used per day.
- d. Number of hours per week spent on systems design or modification.
- e. Number of minutes per day "hands on terminal", and
- f. Number of electronic messages per day.

3.4 Choice of Companies

Paralleling consideration of method, definition of which organizations and which managers had been proceeding.

To reduce the variety of organizational culture the decision was taken to select a single organizational grouping. The following were considered:-

1. The National Health Service
2. Local Government
3. Manufacturing companies
4. Retail companies
5. The Gas industry

A strengths-weaknesses-opportunities-threats (S.W.O.T.) analysis in relation to the research was carried out for each of these

groupings, and from this, manufacturing was selected for these reasons:

- a. This author's background was strong in manufacturing over 25 years;
- b. Manufacturing was likely to include many, or even all, facets of I.T. applications (i.e. shop floor robotics, office computing, and telecommunication);
3. There was a high concentration - twice the national average - of manufacturing in South Bedfordshire (the author's location), thus future employment effects of I.T. were important to the area and the author had previously been involved in a study of employment prospects in the county); and
- d. Manufacturing in the U.K. was considered to be in decline and employment nationally was below 20% of employed population at the time of writing. There was likely to be interest in I.T. effects on the health of the industry by Government, the Manpower Services Commission, the Confederation of British Industry etc.

Next, twelve potential companies in Bedfordshire were identified, and tentative enquiries made via senior managers. Five of these, all of which were well know to the author, were chosen to give a range of situations, and work began. It quickly became clear from the richness of material being uncovered in these companies that they would be an adequate study in themselves. For example, their variety revealed strong differences related to specific organizational cultures.

The companies all requested anonymity, and throughout the following pseudonyms are used:

ENGINEERING)	
)	Mechanical engineering products
HARDWEAR)	

INTEGRAL)
) Electronics
COMPONENTS)

3.5 The Sample of Managers

Because the intention was to discover organization-wide effects of I.T., it was decided to study a cross-section of managers, in several functions, and at several hierarchical levels.

In each case access for the research was given willingly and a high degree of co-operation was forthcoming. Naturally the circumstances and organizational configuration of each company was different, and the exact pattern of interviews, and returned questionnaires, depended on many factors - primarily characters of people and departments, but also the then current economic, social and political climates. The prime objective of the research was always uppermost, and whatever opportunities came were taken to gather data. What emerged were unique cases of five sets of managers, each set operating within a highly specific culture of many dimensions. Each set was different also in the hierarchical, functional and geographical mix of managers, though in every case several functions were represented, and the range of authority was from senior executive (Director level), to junior management. (Definitions of 'level' were specific to each company: 'junior manager' to one could have meant 'supervisor' to another). As will be seen, the material revealed varied substantially, so that although a basic parallelism of presentation is used in Chapter Four, emphasis is somewhat different in each case.

The research included study of a particular slice of each company, namely:

in 'Engineering' - one site (11,000 employees), whole company except manufacturing and technical functions. Company was part of a giant multi-national; (30 interviews)

in 'Hardware' - one site (1,100 employees), all functions on that site. Company was part of large multi-national; (21 interviews)

in 'Fashion' - three sites (800 employees), but mostly on two sites. Mostly production and distribution functions; (11 interviews)

in 'Integral' - two sites (1,200 employees), but mostly on one site, (450 employees), all functions represented on that site. Company part of large U.K. national; (19 interviews)

in 'Components' - one site (2,300 employees), all functions. Company part of large multi-national. (17 interviews).

From the schema introduced earlier, a data base was constructed, having the following elements:

1. Manager's knowledge of I.T.
2. Manager's skills re I.T.
3. Manager's attitudes towards I.T.
4. Current involvement of managers in I.T.
5. Vertical tiers (hierarchy)
6. Number of managers
7. Number of professionals
8. Organizational mode/complexity of structure
9. Functional demarcation/integration
10. Systematization of functions
11. Relations between this unit and rest of company
12. Centralisation/decentralisation
13. Rapidity of data movement

14. Decision making
15. How well informed central/senior managers are about in-house matters, particularly of operational levels
16. Data bases creation/use
17. Ownership of data
18. Automation of procedures
19. Human intervention in processes - "progress chasing"
20. Organizational flexibility/rigidity
21. I.T. strategy
22. Reasons for I.T. applications
23. Sources of push for I.T. applications
24. Post-event analysis of applications
25. Balance of responsibility of manager for people, data, expenditure, physicals
26. Communication patterns
27. Balance of initiative taking/confirming
28. Degree of specialisation
29. Time scales
30. Boundary crossing
31. Role systematization/specificity
32. Balance of planning/control
33. Balance of informal behaviours/systematized procedures
34. Conflict
35. Changes in knowledge, skills, attitudes for management effectiveness (due to I.T.)
36. Manager's feelings about degree of preparation (for I.T.)
37. Future training/education/development needs of managers

The material from each interview was reformatted into this 37 element data base, company by company. Thus, eventually all comments of managers regarding a particular element were brought together. The system provided identification of comments by the function and hierarchical level of managers.

Each interview script was also precised into an 'analysis sheet' pointing up key issues raised by that manager.

From the data base and analysis sheets, and from the question-

naire results, the material was recast for each company into the four themes introduced at the end of Chapter Two, and incorporated in the 'Implications Framework', namely:

- a. General Character of Managers' Work
- b. People Issues
- c. Communications, and
- d. Decision Making

A draft of the description and analysis was submitted to a senior executive in each company and either written or oral comments received. In one case ('Garments') a comprehensive discussion on the material took place with the Personnel Director. At 'Components' a seminar based on the draft was conducted with eight senior managers, including the Personnel Director.

The complete material was also presented, and discussed with, a group of forty managers, not from the subject companies, in 8 one and a half hour sessions. The final drafts benefit from these two mechanisms.

The total method can be summarised thus:

1. Semi-structured interviews were conducted with 101 managers, ranging from Directors to junior managers, in several organizational functions, in the five companies. These interviews were the principal source of research data in this thesis.
2. Five-tone rapidly-completable questionnaire survey used amongst the interviewed managers, and managers not interviewed, in the companies. Although a five-tone scale was used for answers to questionnaires, only three tones (higher, same, lower) are actually quoted, as it was felt the discrimination by managers over five tones was unlikely to be realistic. Caution was exercised throughout in interpreting questionnaire results, bearing

in mind 'halo' effects.

3. Collection and study of published material (company reports and product brochures), and unpublished reports, statistics and notes. Relevant newspaper articles were also used.
4. Observation of managers, and non-managers on 49 visits to the companies.
5. A detailed questionnaire was completed by the manager responsible for computing in each company, which gave historical technical data on the acquisition and use of I.T. in that company. (This manager was also interviewed in depth).
6. Drafts were submitted to, and discussed with, key managers in each company. Oral presentations were made to a group of middle managers (not in case companies).

Interview and questionnaire forms are at Appendices 2 and 4.

Thus the research can be characterised as 'action orientated', with the method developing dynamically from the revealed data, in the style of BESSANT's contingency methodology, mentioned earlier.

3.6 Format of the Case Presentations

In Chapter Four, each company is analysed and reported separately. Within each company analysis, organization functions are, where possible, dealt with in the following order:

<u>GENERIC FUNCTION</u>	<u>TYPICAL DEPARTMENTS</u>
1. <u>Finance</u>	Accounting, Costing
2. <u>Technical</u>	Design, Development, Draughting, Technical Writing.

- | | | |
|----|----------------------|---|
| 3. | <u>Manufacturing</u> | Production, Quality Control. |
| 4. | <u>Supply</u> | Purchasing, Inventory Control. |
| 5. | <u>Marketing</u> | Sales, Public Relations, Advertising. |
| 6. | <u>Systems</u> | Management Information Systems (M.I.S.), Data Processing. |
| 7. | <u>Personnel</u> | Personnel, Training. |

The Generic Function Names (underlined above) are used in each company to give a standard framework, though names of functions, and of departments within functions, differed between the companies, and sometimes within a company. Department names are used where they aid clarity.

Within each function, wherever relevant, descriptions and quotations are given in the tier order of managers, with highest tier first, i.e:

1. Chairman or Managing Director
2. Directors
3. Senior executives
4. Middle managers
5. Junior managers

For each company the order of sections is:

1. Company
2. Information Technology Implementation
3. The Character of Managers' Work
4. Managers and People
5. Managers and Communication
6. Managers and Decision Making
7. Summary of I.T. Effects (for that company)

It would have been possible to describe and discuss the field work under the headings above, combining material from the five

cases. However, the prime issue under study is the work of managers, with all the cultural and structural conditioning, of a specific company. To preserve this cultural integrity, the material is presented as five distinct cases.

The research is primarily a survey of I.T. effects on managers in five companies, and conclusions presented in the final chapter (Five), are drawn from the complete width of the material. However, some comparisons and contrasts between companies are presented in the summaries at the end of each case.

The order of presentation has been considered carefully: 'Engineering' comes first because it has had a long history of I.T. implementation, and manifests a rich variety of implications. 'Hardwear' is second, partly because it, too, is an engineering company, and partly because it is also well developed in I.T. usage. 'Fashion' comes third because it is the least 'I.T. developed', is in a completely different field, and so offers contrast. The two electronic companies come last, for evidently they are quite different, from each other, and from the other companies. 'Components' completes the set, for it may give the best guide to the future of I.T., and managers.

CHAPTER FOUR

INFORMATION TECHNOLOGY AND MANAGERS IN FIVE MANUFACTURING COMPANIES - THE CASE MATERIAL

"Our first mistake was regarding the computer as a glorified accounting machine." **Director - Engineering**

"IT helps me run my business better. We deliberately have a high spread and availability of P.C.'s and terminals - to do a lot more analysis than we used to. The skill is to use the data well..." **General Manager -Components**

In this chapter, the field-work material from the five companies is presented in the following order:

- i. 'ENGINEERING'
- ii. 'HARDWEAR'
- iii. 'FASHION'
- iv. 'INTEGRAL'
- v. 'COMPONENTS'

Each case begins with the I.T. culture in that company, and the extent and kind of I.T. applications already implemented, under way and planned. The influences of I.T. on the four principal dimensions of managers' work, developed in Chapter Two as "The Implications Framework" are then presented. Summaries of I.T. effects conclude each section with brief comments comparing and contrasting that company with others previously described.

The format for each case is:

1. THE COMPANY
2. I.T. IMPLEMENTATION
3. THE CHARACTER OF MANAGERS' WORK
4. MANAGERS AND PEOPLE
5. MANAGERS AND COMMUNICATION
6. MANAGERS AND DECISION MAKING
7. SUMMARY OF I.T. EFFECTS

'ENGINEERING'

1. THE COMPANY : Large scale, designing, manufacturing, and marketing of complex, consumer products, subsidiary of U.S. multinational.

1.1 History

The company began in London in 1903 with their original product, but it was the move to their present site in 1905 which started the saga that was to link the company strongly with the economy and well-being of the locality. Growing slowly and operating largely at the expensive end of the market, this phase was to end in 1925 when the labour force stood at 1,800: 'Engineering' became a wholly owned subsidiary of a giant U.S. corporation. This meant a major change of direction, for from 1930 on, there was a deliberate objective of manufacturing for the growing 'popular' market for relatively low priced products - and by 1934 employees totalled 6,000. Over the next 40 years fortunes waxed and waned, necessarily interrupted by the manufacture of military equipment during the War years, but steadily the company became established as one of a handful of British manufacturers in the field. A 19.5 acre factory came on stream in 1950 in a neighbouring town, making a total of 80 acres of plant, and another plant of 400 acres, with £66 millions investment, opened in the North Midlands in 1964.

The history in terms of employees and of finance is illustrated in Figure 4.1.

By the early 1970s with a total staff of 34,000, 'Engineering' began to face intense foreign competition, in common with all manufacturers of this product in Europe and America. From 1969 to 1984 a loss was made each year, except for 1971 and 1978; the labour force fell to 16,000, its lowest since 1956, and considerable re-evaluation of products took place. During 1984 a major corporate restructuring took place virtually splitting the company into two: one unit (Commercial Products) became part of the parent company's Commercial Division and therefore reported to the U.S. The other unit 'Engineering' became part

of the European Division. This separation of two units, until then bred together and heavily interwoven, was a trauma likely to have repercussions for years, but it does now allow clear visibility of financial viability of both units.

Figure 4.1

Employees, Turnover, Profit

<u>Year</u>	<u>Employees</u>	<u>Total Sales</u> <u>Value</u> <u>(£000s)</u>	<u>Net Profit</u> <u>(Loss After</u> <u>Taxes</u> <u>(£000s)</u>
1953	13836	58620	3426
1954	14880	66631	6861
1955	16487	75112	6542
1956	16151	71293	4634
1957	22084	76000	(1135)
1958	21878	95070	756
1959	26251	130115	6428
1960	24573	35981	7159
1961	23702	117903	4329
1962	24555	125986	5976
1963	27929	14778	8267
1964	32394	188328	8433
1965	33744	195009	13477
1966	32859	178177	4435
1967	32943	190432	3351
1968	36353	216361	5310
1969	35245	204053	(2057)
1970	36291	209912	(9438)
1971	37256*	287787	2613
1972	34312	267486	(4106)
1973	34365	280796	(3683)
1974	33558	320758	(17827)
1975	29586	388843	(12716)
1976	27934	513742	(1860)
1977	30180	627546	(2180)
1978	33344	804880	1976
1979	32732	819496	(31266)
1980	30670	766832	(83347)
1981	23770	761749	(57397)
1982	20527	1060148	(38720)
1983	11519	1094400	(1100)
1984	11931	1308200	(9400)
1985	12467	1565100	(47400)

* highest

Financial statistics include the Commercial Division, which was made a separate company in 1984. Employee statistics from 1983 on are for 'Engineering' only and do not include the 'Commercial' Division.

1.2 Organization

'Engineering's products are complex, involving acute sensitivity to consumers' requirements in terms of appearance, performance and value for money. The basic formula is well-established, though competition forces detail changes, which are complicated, and expensive.

As a subsidiary of a giant multi-national corporation based in the U.S., 'Engineering' has evolved a bureaucracy which might in BURNS and STALKER (1961) terms, be regarded as mechanistic rather than organic.

The company operates basically on two sites: at 'Southtown' (285 acres, 6.4 million square feet of floor space) is head office and manufacturing plant, with 11,000 employees, and at 'Northtown' (294 acres, 4.0 million square feet of floor space), is a second manufacturing unit with 5,000 employees.

At 'Southtown', where virtually all the material was collected, there has been a 25 year history of using computer-aided systems. I.T., in some form, is now involved in Finance, Marketing, Market Research, Spare Parts, Personnel, Reliability, Engineering, Supply and Manufacturing. Although there has been a sophisticated automated transfer line for product assembly for many years, robots have only recently been introduced (in the 'Northtown' plant).

However, the company is a long established user of I.T. hardware and software: over 100 sub-systems are in place, or being developed, in several functions. Many user-departments have 'User-Systems-Planners' (U.S.P's) to assist system enhancement and to liaise with the Management-Information-Systems (M.I.S.) department. The company is perhaps beginning to enter the 'User-orientation' stage described by FRIEDMAN (mimeo 1985) in which system designers give greater significance to user needs.

1.3 The Study

Thirty interviews were carried out, all at 'Southtown', four at

Director level (tiers 1 and 2), nine at tier 3, and seventeen at tiers 4 and 5. Twenty two of these managers also returned the questionnaire. The distribution of managers, interviews and returned questionnaires, are shown in Figures 4.2 and 4.3.

Figure 4.2 Organization and Pattern of Interviews
and Questionnaires by Function

('Southtown' Plant Only)

CHAIRMAN AND MANAGING DIRECTOR				
FINANCE *	MARKETING	SPARE PARTS	RELIABILITY AND QUALITY CONTROL *	MANU- FACTURING
(16)	(32)	(24)	(7)	(16)
[12] 0	[5]	[1]	[1]	[-]
< 9 >	< 3 >	< - >	< - >	< - >
PUBLIC AFFAIRS *	PROGRAMME PLANNING AND STAFF OPERATIONS	PERSONNEL	SUPPLY *	
(4)	(3)	(17)	(24)	
[1]	[-]	[4]	[6]	
< 1 >	< - >	< 3 >	< 6 >	

(17) = Numbers of managers in that function (tiers 1 to 4). (Tier 1 = Managing Director)

[4] = Number of interviews carried out (tiers 1 to 5).

<3> = Number of questionnaires completed.
(In the case of 'Engineering' questionnaires were only completed by interviewed managers).

* Director interviewed.

0 5 of these managers were in Management Information Services (M.I.S.) which was responsible to the Financial Director.

The company was not able to distribute questionnaires beyond the interviewed group.

The author also made an extensive tour of the 'Northtown' plant and talked with several managers there.

Figure 4.3 Patterns of Interviews and Questionnaire by Tier

<u>'Southtown' Plant</u>			
Tier	Numbers of Managers	Number of Managers Interviewed	Numbers of Managers Returning Questionnaire
1	1	-	-
2	9	4	2
3	40	9	7
4	93	9	6
5	400*	8	7
		30	22

* Estimated: Some of these are middle and junior managers, others are supervisors.

1.4 Summary

'Engineering' is a large manufacturing company, (with a current labour force of 12,000 and a turnover of £1,500m) of a U.S. multi-national, with a 25 year history of computer systems growing and spreading steadily, operating in an intensively competitive market, and with a decade of unfavourable financial results. At the time of the study there was cautious optimism prevailing due to an appreciably higher customer acceptance of current products.

2. I.T. IMPLEMENTATION

In each of the five cases, this section is divided into the 'I.T. culture', and 'I.T. applications'. In 'Engineering' section 2.1 looks at those elements in the organizational context, especially (apparent) planning associated with information technology, which seem to have had a strong bearing on I.T. diffusion and usage. How I.T. uses have actually developed in the different functions of the company is dealt with in section 2.2.

2.1 The I.T. Culture

Before perhaps 1980 information technology, in its various formats, seems to have been developing in each of the constituent companies of the corporation in a separate manner without overall co-ordination of hardware, software, or systems. For two decades or more, use of computers and information systems had been evolving at 'Engineering', guided in later years by a 'Management Information Systems' Committee, chaired by the Financial Director. It is noteworthy that M.I.S. was located within the Finance function; I.T. in fact "being seen as a more advanced accounting machine". (E-22). (To maintain anonymity interviewed managers are given this form of reference; E indicates 'Engineering').

Neither the parent corporation, or 'Engineering' seems to have given particular emphasis to I.T. until the last four or five years; certainly it was not seen as a central issue for management before then. The M.I.S. Committee, whilst setting tactical priorities one or two years ahead for systems designers, did not appear to take an overview of the computing-systems- telecommunications arena. No consideration of changes of management structure, or processes, or of preparing managers for a changed environment, were on agendas of this Committee.

A senior Director (E-13) with a long and deep experience of the company suggested that the inherent conservatism, coupled with the corporation's policy of delegated autonomy to constituent

companies, had hindered the spread of I.T. in 'Engineering'. Conservatism inhibited local initiatives, and local autonomy resulted in a lack of compatibility of systems between companies.

I.T. seems to have been visualised in terms of replacing existing paper-manual-mental (P.M.M.) systems, and not as a company-wide change of management processes. Thus there appears to have been no links between M.I.S. and the personnel-organizational-design-training operations.

We are therefore left with the conclusion that there was no explicit strategy for I.T. as a management tool, but that the technology and systems, and their implications have evolved and diffused under the influence of various components of the extant milieu.

2.1.1 Head-Count

Head-count is a major issue. That policy, heavily promulgated from Head Office in the U.S., not only fixed levels for all staff, but calls for a 5% reduction each year for the following five years. While the head-count policy may have been perceived by corporation senior executives and by European H.Q. as a motivation towards efficiency, in the eyes of many managers, even senior ones at 'Engineering', the policy was often experienced as being counter-productive, as it focussed on reduction of labour rather than on improving effectiveness. A very senior manager stated firmly: "Head-count is a nonsense - it is our biggest problem".

Virtually every manager spontaneously introduced the subject - and complained about it - with many unflattering comments about the lack of understanding by distant U.S. executives of its effects on the ground.

Whatever the intention of the policy, the effect was to focus on the substitution of I.T.-based systems for people - perhaps summed up by "you can have as much computing as you like, but no more people", (E-15). I.T. was seen principally as a short term

cost-reduction opportunity (this is the 'cost-saving' orientation of NOLAN, 1979, introduced in Chapter Two, which he claims preceeds the 'added-value' orientation) though other variants such as "productivity improvement" and "labour cost-reduction" were often quoted. While some awareness of the value-adding aspect of I.T. did surface, as will be later described, the emphasis on head-count reduction, may have dulled creativity in I.T. utilisation, which is in marked contrast to the situation at 'Components' to be described later, where competitive advantage was the principal motivator in I.T. use.

2.1.2 Innovation and Change

In interviews managers expressed a comfortable understanding and acceptance of their roles, the company processes, people and traditions. The average length of service amongst the interviewed group was 28 years, and many managers had been in the same department, and often in the same role for several years. Organizational charts were quoted often, and with the well-established levels of responsibility and authority, linked to remuneration and perquisites, gave a more 'bureaucratic' ambience, than in the other four companies. Most managers saw their jobs as secure, and were cautious, and even apprehensive, about innovations which I.T. might bring. Paradoxically, a widely-voiced belief was that 'Engineering' was lagging in its use of new technology: "Well below the average for I.T. use in our kind of industry", was a typical commentary. (E-14).

Training had been well established in the company for decades; also management development, in various forms. However, except for two-day "introduction to new technology" courses for administrative staff, and some managers, there was little evidence of I.T. being seen as producing changed management roles. On the other hand, M.I.S. staff appeared to have been continuously updating their technical expertise. The fluidity and rapidity of systems development and the change effects of I.T. seemed to be dissonant with the risk-averse, strongly structured organizational context that managers had experienced for years. This was confirmed somewhat by the influx of about 100 staff from a sister company in 1983. Apparently these staff

saw their organization as more flexible and innovative than 'Engineering', and it was acknowledged that this group were stimulating I.T. developments. It was also observed that these "upstarts were rocking the boat". Such 'old schoolers' v. 'new schoolers' tension has been noted in the literature on change. (SMITH, 1984).

2.1.3 Personal Computers

The introduction of personal computers (PCs), (that is microcomputers more or less under the complete personal control of individual managers), considerably altered the view of managers towards I.T. At the time of the survey, managers with easy access to a PC found them stimulating and fascinating. Contrasts were stark between managers' views of the main-frame based systems, regarded as restricted, difficult to understand and to use, and 'bureaucratic', and their much more favourable views of PCs. While the main-frame was often thought of as under distant control, a PC was an immediate adjunct to the management process, totally under the control of the manager, and therefore 'friendly'. Undoubtedly the spread of PCs had released a favourable wave of enthusiasm for I.T. amongst PC users.

2.1.4 Corporate Strategy Change

Moves by the parent company must be included here as evidence of the growing centrality of I.T. in the organization's affairs. In 1980 a task force was set up by the corporation to address the communications requirements between manufacturing machines. With 40,000 programmable devices world-wide on shop-floors, and only 15% of these able to communicate beyond their own processes, and with the likelihood of 200,000 programmable devices by 1990, there was obviously a need for massive data linkage. Seven major computer, controls and communications suppliers are co-operating with the company to produce interconnectibility standards. At 'Engineering', this focus was raising the awareness of managers in the manufacturing area of the many issues related to I.T.

In 1982 the corporation, in a joint venture with a major Japanese firm, set up a U.S. based robotics company, which has since then taken a 19% share of the market for industrial robots.

In July 1984 the U.S. corporation purchased a Dallas based systems company, 'D.C.R.', - one of the biggest U.S. suppliers of computer services. This company will continue trading in its own right, but will now be responsible for data processing services in the corporation. To that end in January 1985, 300 systems employees at 'Engineering' were offered, and accepted transfers of employment to the systems company. The corporation's intention to create new products and production management systems using sophisticated technologies, stated publically, is another signal of a change of strategy.

2.1.5 Stated reasons for adopting I.T.

Not a single manager mentioned 'increasing control over labour' as a reason for adopting I.T. On the contrary, managers tended to perceive the technology as releasing staff from mundane and boring tasks so they might engage in more fruitful jobs, and could use their own initiatives more. This contrasts with Harry BRAVERMAN's thesis (1974), that management strategy toward new technology stems from an engineering view of work and workers. Braverman claims that in order to reduce variability deriving from independent worker initiatives, managers try to separate out conceptual activities from execution, and to concentrate conceptual activities among fewer workers. This analysis has stimulated a great deal of research into the labour process in Britain and much work has confirmed Braverman's predictions especially where observation has occurred over short time periods. When a longer time perspective has been considered, some conflicting evidence has emerged (FRIEDMAN, 1977). The focus of research in this thesis is on managers' work, and not on implications of technology, on 'workers', as has been a central, of not overwhelming, focus of the literature. Nevertheless, it was interesting that managers interviewed in 'Engineering' appeared to see I.T. as releasing initiatives in subordinates.

2.2 I.T. Applications

2.2.1 The History of I.T. in the Company

<u>Date</u>	<u>Comments</u>
1960-1966	100% batch entry to main-frames. Payroll; general ledger.
1967-1973	100% batch entry; computer-to-computer links with 'Northtown' plant; added: material and production control; engineering and personnel records.
1974-1978	Main-frames 1.5 millions of instructions per second (M.I.P.S.); computer-to-computer link extended; 100% batch entry.
1979-1980	Main-frames above 2 M.I.P.S.; 85% batch, 10% remote job entry, less than 5% on-line. 25 terminals in use. 5 mini-computers. 48 staff in M.I.S.
1981	100 terminals in use; 80% batch, 10% remote job entry, 10% on-line.
1982	400 terminals in use; 65% batch, 15% remote job entry, 20% on-line. 10 personal microcomputers.
1984	40 M.I.P.S.; 600 terminals in use, including 90 graphic terminals, 54% batch, 10% remote job entry, 36% on-line. 40 personal computers. 50 word processing stations, 40% of on-line use is for graphics. 30 minicomputers. 108 staff in M.I.S. System now encompasses: engineering design and parts, manufacturing assembly, accounting/costing, dealer voice-response, order data, purchasing and warehousing payrolls, personnel and previews.

The above data include the Commercial Division which became separated in 1984. Approximately 60% of facilities mentioned apply to 'Engineering' as it is now.

There has been then, more than 25 years of computer usage in the company, though until the last four or five years there were few terminals or free-standing personal computers outside the Management Information Systems function (M.I.S.). Since 1980 M.I.S. 'User-System-Planners' (U.S.P's) have been working in operational departments, assisting in system analysis, design and implementation. Managers within the company therefore have a long-standing cognition of M.I.S., though the extent of I.T. use and influence in functions and in departments varied. The

awareness of I.T. was widely claimed to have increased in recent years, though the actual use of equipment and systems was different for each manager.

2.2.2 The Finance Function

The Finance department, with a long history of Hollerith punched card machines, moved to main-frame computer in the early 1960s and a 'Management Information Services' (M.I.S.) unit was formed, reporting to the Finance Director. In spite of this early start, the function seems not to have been overly enthusiastic about computing, and a commonly expressed opinion of non-financial managers, was that the location of M.I.S. within Finance had inhibited the pace of diffusion within the company. E-13 (Director): "Our first mistake was regarding the computer as a glorified accounting machine; M.I.S. has been too finance orientated ... we have consequently missed applications in production and elsewhere".

Typically, managers in the function felt that systems development in Finance was far too slow - that "Finance line managers had not shouted loud enough". (E-11). This slowness in I.T. usage was ascribed variously: a senior executive (E-22) felt that the rate of systems development was limited by the quality and training of managers, but claimed also that 'Engineering' was in line with sister companies in Australia and Germany. Although M.I.S. was technically within the finance function, it was regarded as distant and "only responded when user-managers were sufficiently clued-up to see an (I.T.) need ... and most managers lack data-processing skills and systems understanding - they don't know what can be done - and are very protective of their (traditional) roles and jobs". (E-16).

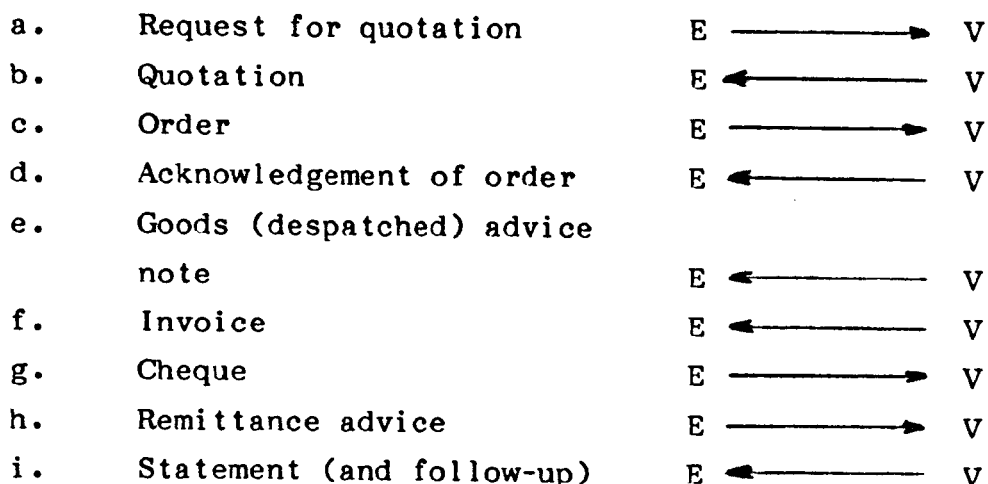
Commonly, the lack of integration of approach was quoted: "There is a need for a Finance systems co-ordinator ... across the board ... we don't know what the other (sections) are doing". (E-20). A similar view came from E-21, a young (32) well qualified and energetic manager: "Each case is cost-effectiveness driven, but separately - a fragmented approach. We need a corporate strategy for systems, and this

may come out of D.C.R." (the newly acquired systems company). E-16 said: "I.T. development is too slow because we seem to be tackling everything from the ground up ... systems don't connect together because they were designed separately - there's no clear strategy".

Nevertheless the function had experienced twenty-five years of extensions of computing first into "transaction processes" (level 4, HEAD, 1967,): payroll, accounts payable, receivables, general ledger, and later into operational control (level 3). There had been continuous upgrading of sub-systems - indeed at the time of this study 'User-Systems-Planners' were actively engaged on several fronts, with personal computers the catalyst to get things moving. (E-16). "PREP", introduced in 1984, enables invoices to be verified against goods-received-notes, and against orders placed, and automatically produces and authorises payments.

A sophisticated data exchange system A.P.T. was nearing introduction date. Transactions by paper between the buyer, 'Engineering' (E), and the vendor (V), had been multiple for virtually all purchases, as shown in Figure 4.4.

Figure 4.4 Purchase Transactions



A.P.T. will allow all these transactions to be electronic (i.e. paperless) and typifies implications of sophisticated I.T: reduction in number of transactions, increase in transaction speed, and thus reduction in transaction elapsed time; and integration of sub-functions.

Although this application is technically at level 4 (HEAD) i.e. transaction processing, it also carries out operational control, and decision making (level 3), which would have been the province of managers. Another system, BIGL, (General Ledger), will similarly speed up transactions, and produce sub-system integration. The UNIPAY-UNIPERS-UNIPENS combined pay, personnel files, and pensions system, uses a common data base and is pulling together previously separate sub-functions of Finance, and creating links into the Personnel function - another example of I.T's integrating effect.

Several managers gave the impression that I.T. was being utilised to speed-up existing accounting procedures, and to increase labour productivity (the 'cost-saving' orientation). E-5: "The decision to computerise an area was forced by the cost of manual (P.M.M.) systems".

Surprisingly perhaps, there was little voiced opposition to I.T., rather a muted confusion about strategy, co-ordination, managers' roles, and change.

2.2.3 The Supply Function

In 'Engineering' the Supply function covers purchasing, inventory control and the management of world-wide movement of company products and product components, and was considered by interviewed managers as having increased in importance in the company, over the last few years.

A computer driven system was "brought from the U.S.A. in 1967, but nobody in 'Engineering' would accept it ... it has taken fifteen years to remove obstacles. There was no real understanding of systems ... no idea how to start implementation", (E-15, a senior executive). "'Engineering' is

well below the industry-average (for our product range) of I.T. ... I am brassed off with the slowness of movement into computer systems. The basic problem is the 'pay-back' discipline - cost-benefit-analysis has been thin - a lot comes down to how well the cheating is done. There is a need for management to review benefits in an enlightened way". (E-14).

But undoubtedly the interviewed managers "now know we can't compete until we get into I.T.". (E-15). "And being so far behind we don't have time to learn slowly - we need to ask deep questions about total effectiveness". (E-14). "The department had embarked upon several major projects using I.T. - the cornerstone of the future". (E-9), and it was clear there was now enthusiasm about the future of I.T. systems.

The motivation in Supply to use I.T. according to E-10 was to save money, to speed up operations, and to improve data quality. The integrating effects of I.T. (the department is involved in the PREP system and so linked with Finance), and the 'acceleration' produced by personal computers, was commonly mentioned. "We are getting as much data as possible onto the P.C. - we can reformat information faster". (E-6).

Several 'transaction processing' (level 4) sub-systems were in place, with some level 3 (operational planning and control) sub-systems computerised. PCs are now being introduced for level 2 (tactical) decision support. Although a full listing of all sub-systems was made available to this researcher, it is confidential, and it was not possible to specifically classify sub-systems into the HEAD characterisation of I.T. applications.

2.2.4 The Marketing Function

As in Finance, and in Supply, certain systems were computerised but frustration was expressed at the lack of understanding by M.I.S. of the I.T. needs of the function. The D.C.R. (systems company) initiative was welcomed, as acute awareness (to be expected in Marketing) of the competition was often stated, coupled with anxiety that 'Engineering' was lagging in its use of I.T. based systems in Marketing.

There was an entirely different attitude toward I.T. in this function - a considerable enthusiasm for creatively developing the potential of the technology. "Systems are being pushed heavily because excellence in that area is worth a gain of 1% of market share". (E-8).

'Product Planning and Forecasting' was using I.T. intensively, producing very sophisticated management reports on product sales and forecasts related to various economic indicators. The team were using one P.C., two terminals on a time-sharing service (external to the company), one terminal on-line to the corporation headquarters (abroad), and three terminals on the local main-frame. It was clear that in this section the availability of instantaneous connection to, and interaction with, several data bases inside and outside the company was a significant facilitating element. Similarly, the speed of compiling and reformatting data by I.T. had transformed the unit. "We have no clerks; virtually every staff member has a degree; every piece of paper is produced by computer". (E-12).

A second area of extensive change due to I.T. was in a voice-response enquiry system which dealers could integrate to obtain data on status of their already placed orders. The system was dealing with 28,000 transactions per day and had "dramatically reduced telephone calls and cost - and had reduced head count in the section by ten people while doubling the work throughput". (E-27). Because of advances in, and reductions in cost, of the technology after only three years use, the voice-response arrangement would be shortly replaced by viewdata, which was expected to improve productivity and quality of service.

The objectives of using I.T. in this function were not so much reduction of head-count, though this was mentioned, but more to gain from the value of fast and accessible data (the 'value-added-orientation').

2.2.5 The Personnel Function

In Personnel, except for the introduction of the UNIPERS (linked

with UNIPAY and UNIPENS) package, there was little direct use of I.T. There had been some involvement in identifying training needs, and the Management Training section had run a series of two-day 'Introduction to I.T.' courses. This was a case of low order direct effects of I.T., but the department was being influenced by concomitant I.T. effects, i.e. reduction in number of people in the company generally, and on changing required skills, and training.

2.2.6 Other Functions

It was not possible to organise interviews with managers in Technical or Manufacturing. In Technical sophisticated systems were in place for engineering design, specifications and planning. Manufacturing had reputedly been tardy in using I.T. but a highly complex automated, and computer controlled production shop, at a cost of £68 million, came on stream in 1986, and training for supervisors and staff is in progress.

3. THE CHARACTER OF MANAGERS' WORK

Although the average length of incumbancy in the current job of managers studied was three years (this was partly due to a spate of new job titles and roles over very recent years) total service with the corporation, and usually that meant with 'Engineering', was twenty-eight years. Thus, this group of managers are deeply imbued with the role and process traditions of the company. Further, the managers have typically spent most of their careers in the same function, and often in the same department. This issue surfaced often: managers regretted not having moved around the company more, and were aware of their rather limited view of the organization. The value of job rotation was understood, particularly in the context of the current pace of change, and feelings were expressed that there was a lack of company policy on giving wider and different experiences to managers.

3.1 Sources of Change

Information technology was thought by over half the respondents to be the most important source of change in the company, with the increased use of PCs and the D.C.R. acquisition being often mentioned. The separation of 'Engineering' from its sister 'Commercial' company was quoted by a third of interviewees as a significant source of change. The greatly improved market share of the company over recent years, and its implications in work load and pace was also quoted widely. These three issues surfaced in nearly every interview: increased market share often being associated with developing the potential of I.T. to gain maximum competitive advantage in product terms, and in data speed and access.

'Main-frame' computing has existed in the company for twenty-five years, so managers have operated for years in an I.T. milieu, though its influence on them, and their tasks varied widely. There was a tendency to be oblivious of this 'old-generation' computer environment, and several interviewees said that had made little difference to their activities or management style.

3.2 Variability of Change

All the interviewed managers were primarily involved in 'intelligence', that is data gathering, analysis, and dissemination, although much of this used 'conventional' paper-manual-mental (P.M.M.) systems, often in independent sub-systems separate from the main-frame network, which had evolved tactically with no company-wide overview. But there was clearly a gradually increasing involvement of managers in system design and modification and in I.T.-driven applications. It is important to register that the influence of I.T. on the activities of managers was variable: each manager had a unique story. Often where managers were directly involved in designing, or establishing a new system, the implications of change itself were entangled with the implications of I.T. Another manifestation was the relative lack of awareness of managers of gradual changes over the years. For instance it was often claimed that long established main-frame based systems had little effect on managers, yet at the time of the study over a

hundred sub-systems were being used across the company. It is hard to imagine that these widespread systems had had so little effects as were claimed evolving as they did over more than two decades.

3.3 I.T. Involvement of Managers

There was no doubt that the gradual long-term diffusion of I.T. throughout the company was changing the emphasis and priorities of the highest level executives, though they often had little direct contact with systems matters. The Financial Director, who through his chairmanship of the M.I.S. co-ordinating committee was concerned with broad systems strategy, was exceptional in his intimate involvement with I.T. issues.

At middle management levels the degree of I.T. involvement varied considerably.

Apart from the I.T. specialists, the time spent directly on systems issues by most managers was small.

Figure 4.5 I.T. Involvement of Managers

(From questionnaires)

	A	B/C	D
VDU in office: per manager	.7	.1	0
PC in office: per manager	1.0	.2	.1
Number of packages used daily	3.2	2.1	.4
Hours/week on systems issues	13.3	12.1	1.1
Minutes/day on terminals or PC	137.5	18.4	0
Electronic messages sent/day	5.5	.2	.1

'A' managers are specialists in I.T., for instance in M.I.S., or computer departments, or an exclusively I.T. orientated role in a functional department such as Marketing.

'B/C' managers are 'more I.T.-involved' on the basis of use of hardware or software, or involvement in systems design or modification. The dual letters B/C are a reminder of the range of involvement. 'D' managers are 'less I.T.-involved'.

These classifications, introduced in Chapter Three on Method, are used in all five case studies.

As introduced in Chapter Three on Method, wherever possible for each company, functional units are dealt with in the same order, namely: Finance, Technical, Manufacturing, Supply, Marketing, Systems, and Personnel. These generic function names are used in each company to give a standard framework, although names of functions, and of departments within functions, differed between companies.

At the highest level in Finance, I.T. had little direct impingement on executives, in terms of use of terminals, use of software, or system design. The broad financial control of the company was their principal preoccupation. However, M.I.S. was a part of the function, and the M.I.S. co-ordinating committee, meeting every quarter, reported to the Director. He was thus concerned about, and involved in, "broad M.I.S. strategy decisions". There was no doubt that the implications of the gradual diffusion of I.T. throughout the company, was changing the emphasis and priorities of these highest level executives. "Cost structure is the main issue - volume is the key to success and this means styling and engineering first, then production for quality, then marketing, and delivery - and all these involve systems". (E-22).

At middle management levels in the finance function the degree of I.T. relatedness varied enormously. However, managers virtually uninvolved in I.T. (E-11) were sensitive to systems issues: "Insufficient resources have gone into systems development ... our line managers in the function have not shouted loud enough - but the company has rarely invested in people ... we are insufficiently informed on systems and their benefits". His actual activities, however, had been little changed by I.T. Likewise a manager (E-21) still had a

'traditional' job, with 30 clerks "pushing paper" and little computer assistance. "Essentially people based", he said, "the skills amongst my staff are systematic repetitiveness, - with tolerance. The only way out of their jobs are dead mens' shoes". None of his staff were professionally qualified - "few people have ideas about what needs doing, and how". Here, then was a conventional 'paper-manual-mental' (P.M.M.) section - perhaps typical of 'pre-I.T." departments in the company, dealing with paperwork in bulk by repetitive, simple, but time-consuming transactions.

While there were written down codifications for some of the procedures, in the daily hurly-burly, there was no apparent reference to written rules. More difficult issues were referred up to supervisors, and if necessary to the manager of the section. The young (aged 30) manager's activities were 'conventional' - but he was involved in bringing in the PREP scheme, and was well aware of the imminent changes consequential upon I.T. based systems.

The other five managers interviewed in Finance were all intrinsically involved with new computer systems (and had an age range of 32 to 60). Typical was E-18, who at 54 had been with the corporation twenty-seven years, and although he had no formal qualifications, his experience of administration and accounting management was wide. He was working on A.P.T., described earlier, having participated fully in the introduction of PREP in a 'sister' company, although his main responsibility was running an accounting section. Over the years his emphasis had increasingly moved to systems, and he talked fluidly of systems design and modification, and the influence of main-frame and PCs on accounting work. "The skills I now require are understanding the system, in reading computer produced management reports, system planning ... and to see greater possibilities for action (revealed by computer reports)".

'Systems-orientation' of I.T.-involved managers, as distinct from non-I.T.-involved managers, was often clear. 'Systems-orientation' meant seeing jobs of individuals, and task processes, as elements of a total schema, each fitting with

other elements. Data format, routing, and timing seemed to be more important to these managers. A Supply manager (E-6) declared that 60% of his job was new systems design; he was user representative in an on-line purchasing project with 'sister' companies abroad. Using a free-standing P.C., he was analysing data for monitoring buying prices against budget figures, and for auditing cost reduction programmes - design support systems. In some ways this man typifies the emerging changing nature of an I.T.-involved manager's role: managing a small team of eight people (down from 12), producing and using fast, accurate, analyses to guide buying decisions. "... fewer clerks, less routines, and more individuality and creativity ... I can take more initiatives". (E-6).

In the Traffic department two associated managers told a similar story. The traffic manager (E-9), responsible for controlling the movements of finished products, and sub-assemblies, all over the world, was clear that his role as systems designer was steadily increasing. Several major I.T. projects for monitoring and controlling incoming supplies to 'Southtown' plant were implicating his department with the ultimate objective of a computer-controlled-integrated system. He spent 25% of his time on I.T. related activities, and this was increasing. Data gathering and data progress-chasing consumed 80% of his time in the past, he estimated, but with I.T. this was decreasing, allowing more attention to decision-making. "I.T. is the salvation of this department - it's taking away the chaos".

To summarise: it was observable that as I.T. entered a function, especially with PCs, and on-line facilities, managers previously occupied mainly with monitoring the activities of their section, became more implicated in the design of and analysis of systems. The focus of managers appeared to be less on the monitoring of people, and more on how the system works, and on data issues.

3.4 Pace

The perceptions of most interviewed managers was that the pace of their work had increased, though there was no differentiation between I.T.-involved and I.T.-uninvolved groups. Similarly all

managers said their time for reflection was the same, or less than it was five years ago. Observation suggested that I.T.-involved managers were often extremely busy, perhaps partly because they often were installing a new system while managing the existing situation. However, there was a widespread tendency in the B/C group to use words like "pace", "reactive", "responsive", "rapid decisions", and to generally give the impression of being pressed by the system to respond quickly.

It is important to register that there are differences between the appearance of an I.T.-involved group of staff, and a non-I.T.-involved group of staff. With increasing amounts of I.T., there is an impression of decreasing volume of physical motion and movement of staff, and of the managers themselves. Pace, therefore, is much more linked with the response time required, rather than with physical movements of either people, or paper.

3.5 Fragmentation

High fragmentation of work was common: managers appeared to be working on many tasks simultaneously, commonly with many interruptions, and direction changes. I.T. appeared to decrease the routines in a manager's job, and also to decrease the degree of formality. As I.T. took over P.M.M. activities, codification of processes increased in terms of data specificity, timing, formats, routing, and authorisation to access data. For instance I.T.-involved managers were beginning to experience a closer time-fit between components of the organization's overall data system. The monitoring of these facets is often an integral part of the machine system - (E-18 reported that if an invoice was unpaid after 99 days, the system flagged up the situation in "no uncertain terms"). Guideline signals on visual-display-units were commonly used to prompt staff to input appropriate data, and complete data. Thus whereas P.M.M. activities often had 'soft' disciplines, and covert signals for managers, I.T. systems imposed tighter disciplines, and used overt signals to staff, and managers. E-28: "I don't have to walk out of my office to know what is happening - it's on my screen".

It became clear that it is necessary to differentiate the effect of I.T. in terms of specificity and codification, on tasks (data transactions), on staff, and on managers. Data transactions are certainly becoming more codified, staff jobs are influenced differentially (some became less codified), and managers' roles become even less prescribed.

3.6 Planning and Time Horizons

There is a sense in which all activities of a manager can be categorised as dealing with the present, or preparing for the future. It is tidy in concept to see planning as a distinct activity as per FAYOL (1916), but in practice managers move their time dimension from the present to the future (and to the past) instantaneously and often. The same sentence often deals with a query for which an answer is needed immediately, and gives a subordinate advice on future consequences of that answer. It was enormously difficult for managers to disentangle the degree of futurity of their own behaviour. Interviewed managers at 'Engineering', paradoxically, appeared to be as overwhelmed with that day's detail as they ever were, in spite of a reduction in numbers of staff reporting to them.

But managers did believe they gave more priority to planning. A Personnel executive (E-1) was consciously putting more of his time into strategic thinking and planning, rather than reactive tactics. In Marketing, a relatively mature and sophisticated user of computer based systems, E-8, felt a definite effect of I.T. based systems was to create more time for managers to plan: "Less time is needed on 'controls' because the machine system carries out lots of cross-checks". On the other hand, E-17, a User-Systems-Planner in Finance, felt that managers with whom he was working on the design and implementation of new systems, were too involved in day-to-day detail: they found it difficult to stand back, and conceptualise about I.T. systems. "Systems design requires 'total' views of the operation, rather than narrow, detailed views - and our managers are not used to this way of thinking.

In fact, he speculated that supervisors and managers have in the

past been promoted because of their 'action' orientation and their people handling skills. Now a different management approach is needed with a longer time horizon, about data cost, data values (etc) as they will develop in the future. In fact, most managers thought their emphasis on planning and strategy had increased - independently of I.T. - though in 'Engineering' I.T.-involved managers perceived time horizons to have increased more than 'non-involved' managers. Here again the paradoxical nature of I.T. implications was evident: the rapid response characteristic of I.T. systems tended to increase a manager's focus on the immediate, while at the same time fast I.T. analyses and data access allowed a greater time horizon, and 'what if' speculations.

3.7 Summary

The characterisations of managers' work in the literature (for instance STEWART, 1967 and 1976; MINTZBERG, 1973; and McCALL, 1977) introduced in Chapter Two were confirmed. The interviewed managers were busy people, switching their attention frequently between the many demands on their time. They were deeply imbued with the role and process traditions of the company - most having spent the greater part of their careers with 'Engineering' - often in the same department. New technology and its effects were commonly viewed with caution, if not apprehension, although there were enthusiasts too in most departments.

Managers seemed relatively oblivious to the gradual evolution of 'old-generation' computing over two decades but undoubtedly I.T. was now seen as a major source of change. Matters of 'intelligence', always important for managers, took on a greater priority: systems and data issues began to displace administration of people as the central focus of managers.

While I.T. brought increased codification in terms of process routines, timings and formats, the roles and work of managers continued to be largely undefined. Indeed flexibility, creativity and tolerance of ambiguity take on an even higher significance for managers as I.T. becomes routine.

4. MANAGERS AND PEOPLE

As in all organizations, the concerns of managers in 'Engineering' were various: market acceptance of product, fierce competition, financial viability, to name three. But throughout the study, undoubtedly managers had an acute awareness of the sheer size of the company, not least represented by the 15,000 people in the labour force. This total, although less than half the 37,000 at its maximum in 1971, is still considerable. Not surprisingly, 'people issues' have been fundamental, with much emphasis on personnel matters - remuneration, conditions of employment, health and safety, pensions and union grievances. Personnel, Training and Industrial Relations departments are well established, and 'people' aspects of managers' roles ran through most discussions with interviewees.

As the literature, and especially the popular press, suggest that information technology applications will reduce labour, and change skills, this subject was aired extensively in all five companies, for if this were true, then an important dimension of managers' work would be changed.

4.1 Numbers of People

The evidence throughout 'Engineering' was that numbers of staff at all levels were reducing. As mentioned earlier, head count receives continuous and important emphasis, with a corporation expectation of 5% reduction in each of the following five years. Naturally, staff reductions are brought about by several mechanisms, only one of which is through the use of technology. There was another complication: titles of jobs, and of departments, and the company's structural arrangements, have been constantly changing over the last few years, and, perhaps deliberately, make direct 'before-and-after' comparisons of numbers, impossible.

However, many managers gave examples of reductions - associated with I.T. E-23 was clear that to offset head count reduction in Finance, increasing I.T.-based systems were the principal

answer. In 'Accounts-Payable' where 88 staff had been employed, E-21 explained that as PREP (invoice checking) system was coming on-stream there was a steady fall in staff numbers - he, in fact, repeated the 5% per year figure. Both the APT-ODETTE, and BIGL, systems (mentioned earlier) were expected to reduce staff by around 20%.

The questionnaire returns showed that managers had experienced a fall in numbers of subordinates over the last five years, and virtually unanimously a steady continuing reduction in staff associated with increased I.T. usage was anticipated. Managers, too, have decreased in numbers, and a trend towards a flatter hierarchy with larger spans of command for managers, was often expressed. In one instance, in the factory a complete strata of foremen had disappeared.

Because of the political connotations of a reducing labour force, managers were careful not to be specific about such examples, and in particular, did not directly link staff reductions with increased I.T. Post-event analysis of I.T. applications were rarely made in an exact and formal manner, if at all. Also because of the patchy and overlapping nature of systems development (for instance more than one system might apply to the same process and group of staff), it proved impossible to generate a direct connection between I.T. applications and staff reductions.

4.2 Skills of People

Throughout the study managers reported that as I.T. increased in usage, the skills needed by their subordinates were different, and usually more sophisticated.

In interviews managers tended to be vague about the skills their subordinates had. Apart from hand-eye co-ordination skills of jobs like typing, the skills used in clerical-administrative-professional jobs are indeed difficult to understand and to identify. There was also a tendency to talk about needed knowledge, skills and attitudes in a generalised undifferentiated way. This is not surprising. Firstly, because in real

work situations they are not separate, and secondly, because it needs a high order of trained observation to make distinctions between knowledge, skills and attitudes. Further, this thesis is primarily based on the views of managers of their own roles and activities, and this involves their perceptions of the skills and activities of their staff. No data was taken in this study of the views of clerical staff of their own skills and activities. By and large, managers seemed to regard new skills as 'higher' than old skills, (and perhaps some of them are). It is probably prudent to be aware of this viewpoint in the comments which follow.

In Marketing the proportion of educated/professional staff to clerical staff was reported to be increasing: in fact, the department had just hired ten graduates (September 1984) - many more than the norm over the last several years as part of a strategy to improve the calibre of staff. (A manager in the department (E-8) was quite sure the relative slowness in developing I.T. systems in that function was due to a lack of people with I.T. skills and knowledge). Specifically in the Marketing Services section the staff had completely changed in the last three years. Virtually every member now has a degree (in Economics, Business Studies, Mathematics or Engineering) with Higher National Certificate being the minimum qualification required. E-12: "Initiative taking in the group has increased 100% in the last year - I just can't get them off the computers - there's lots of creativity now - it's a common occurrence for someone to think of something new". Everyone in this section was now a qualified professional intimately involved in I.T. systems - there were no clerks. Parallel stories came from Supply. E-6 felt his staff were now more creative and individual - and eagerly using I.T. In Material Scheduling, E-7 said his staff were more aware, more sophisticated in terms of their understanding of company practices, and more flexible. The Traffic Planning manager was convinced his staff's roles were changing steadily as I.T. was used more, with increasing skill in the use of, and analysis of, data. Both E-10 and E-15 felt that new entrants to their sections would have to be at a higher academic level, and to be more skilled in systems.

In Finance, the emerging picture was similar. A senior U.S.P. (E-17), drawing upon a considerable experience of putting in new computer systems in the company, expressed the view that there was a release of 'dormant' skill amongst clerical and supervisory staff as they moved over to new I.T. based roles. "This skill is in analytical and 'systems' thinking, and in 'logical' skills (he actually thought these were analogous to engineering skills which might have been frustrated years earlier) in understanding relationships between data sets, and using 'building block' approaches to information". Clerical roles in P.M.M. situations were often repetitive, to the point of acute boredom, according to E-17, but when I.T. took over the drudgery, the jobs that remain took on an interrogative, analytical component, which (he said) was stimulating. "The active role is less prescriptive even though the system dimensions are more prescriptive".

With manual arrangements, clerical staff often had a narrowly drawn task with little knowledge of the larger view beyond that task, and a tight delineation of authority to take decisions. Exceptions were constantly passed up to supervisors and managers for advice and decision. E-17 claimed that with computer based systems in Finance, gradually increasing connections were growing with other departments because electronic data flowed so easily across boundaries. Thus there was an increasing tendency for clerical staff to know about systems and data from outside their functional boundaries. There was also the pressure from electronic systems for speed of response. The system operates and communicates so quickly that it tends also to catalyse people to operate more swiftly (for instance in inputting data and decision making).

Because of these two elements (knowledge across boundaries and speed), clerical staff or junior managers are more likely to deal with exceptions themselves.

This was expressed clearly by E-18: "As an I.T. system comes on stream, and after the initial staff resistance, each clerical and professional person has wider scope, and requires increased 'system' skills, and communication skills. People apparently

see themselves as more technically expert".

There was a tendency then for managers to have fewer people to manage, but these people needed to be, and were becoming, better educated, more systems aware and skilled, more flexible and responsive to changing demands, and maybe more initiative-taking than was hitherto expected of them.

4.3 Management of People

Organization charts were much in evidence, and managers talked, almost without exception, about their position in the hierarchy, and were clear of their reporting lines and responsibility limits. Status and authority level were delineated relatively obviously. Also, there was little tradition of role rotation - in fact most managers had been in the same function for many (tens of) years - though again this was difficult to verify because of the several organizational re-arrangements which erased old jobs, or their titles, and created new ones. The long functional incumbency, which was the rule rather than the exception, implied reinforcement of functional boundaries, and an ongoing confirmation of conventions.

The overwhelming impression was that the 'people dimension' of managers' jobs in 'Engineering' has had a strong component of complying with, and gaining compliance amongst subordinates to, a well-established and relatively bureaucratic set of functional and hierarchical expectations.

Initiatives had generally not been encouraged - indeed E-1 (Personnel) tactfully underlined this in saying "there is always a tension about initiative-taking in a company of our size". The sheer numbers of people in the company, many in relatively level clerical activities, meant that the 'personnel administration' within managers' jobs, i.e. issues about time-keeping, absenteeism, grievances, day-to-day communication, and standards of work, had to take priority. In addition, the organizational milieu was low risk, long job incumbency, and as one manager said "keeping heads below the parapets". E-1 (Personnel) commented "personnel administrative tasks have been identified,

and were there to be carried out". As P.M.M. tasks decrease in bulk, and I.T. based systems increase, the number of staff at junior administrative levels is decreasing. The administrative and professional staff who remain are gradually becoming more individual, analytical, flexible and better educated. E-1: "We are trying in the Personnel function to respond to people's needs - i.e. changing procedures to suit requirements; less prescriptive and more responsive". E-2 (Training): "The company is moving away from mechanistic operation and towards organic operations and there is an increasing requirement for more discerning and participatory management".

Various examples of this embryonic 'colleague orientation' came up in discussions. E-1 again: "It is more difficult to understand roles these days; there is something inherent in what is happening which makes roles less clear - the department monoliths are disappearing. For instance, there is a greater need to be able to serve more than one boss. Flexibility is a premium skill". E-6 (Supply): Responsibilities are becoming less precise because more initiatives are possible. I.T. gives more time for me as a manager to treat my staff as individuals". E-7 (Supply): "My total people issues remain about the same as a proportion of my job - there are fewer people because of the technology - but they are more aware and sophisticated in company terms. I am continually working towards more interchangeability of staff - more flexibility and more responsiveness".

In Marketing, E-8, a man with 40 years experience, emphasised the importance of people issues: "The computer system will handle business needs but managers will still have to handle people - carefully, and differently from in the past". An example of this change in the people dimension was given by a young manager (39) in Marketing Services. He (E-12) described a unit and a people management style rather different from the norm at 'Engineering'. Since his return in 1981 from a three year stint in an American sister company, his section now comprised almost all graduates - young and extremely involved in I.T. and systems, with a high level of initiative taking and creativity. In a later interview one of his subordinates, E-25,

confirmed the picture of an organic, enthusiastic team with profuse one-to-one transactions, and low hierarchical profile. In fact this section was similar in these characteristics to these found organization-wide at 'Components' where there was deep involvement in I.T. systems practices (to be described in the last case study of this chapter).

Several examples of transitional management-of-people styles were apparent, as managers wrestled with the emerging increasing 'independence' of individual staff and more junior managers, and the reduction in numbers of people relatively conforming to set expectations. In Finance, not noted within the company for perceptive people-management, E-11 stressed that personal career planning was becoming more important. He felt staff were more demanding about 'what was happening' and he welcomed the current new focus on training in the function. It was now clear to him that payscale strategies to "attract people competent in I.T." were essential as "very rarely in the past have we been prepared to invest in people to get our systems right". E-19 in another financial section made similar points: "previously we had so many staff lower down the hierarchy (he meant clerks) that we just couldn't know them. Now because of I.T., we have fewer people, and we have time to think, and that means also, to think about people".

An enthusiast for I.T., in Supply, E-9, gave a different angle. He felt that as the I.T.-systems elements in his section were growing, there was a tendency to move away from managing people, to managing tasks, and focussing on problem solving and decision making.

However, generally, interviewed managers said little about training unless prompted, and evidently it was not a prime focus. Wherever it was mentioned it was recognised as important, but lacking. E-20 (Finance): We have not backed something vital - training and preparation of managers and staff for I.T."

A Director, E-13, in a sense, summed up the changing attitude towards people: "We are heading toward a much reduced labour

force, with far fewer managers managing a higher calibre staff. The historic level of distrust between men and management still amazes me. With high technology processes there has to be a coming together to avoid conflict. We need more people-management, more team building, less industrial relations problems, and that means higher qualified and trained managers".

4.4 Summary

There has been a steady reduction in numbers of personnel, undoubtedly partly due to the increased use of I.T., though specific numbers were rarely forthcoming. There were fewer managers too, with flatter hierarchies.

Where I.T. was much used, managers believed their staff had higher skills, were more professional, better qualified and more enthusiastic. While specificity of systems was increasing, role specificity of both managers and non-managers was lessening. Conventional personnel administration was giving way to a less prescriptive, more responsive 'team management'.

5. MANAGERS AND COMMUNICATION

As discussed in Chapter 1, managers are intrinsically pivotal in the intelligence, and interpersonal processes of organizations. The degree of 'hardness' of data, that is, formality, structure and representation by numbers varies widely. Accounting records and procedures may be very 'hard', while descriptions of people, or politics, are much more formless and unstructured. Communication by managers, in their normal fragmented roles, may include a variety of modes and a variety of data types, sometimes separate in time, but often simultaneous, as when discussing hard financial data displayed on a terminal screen, with other managers.

This complex character was found in all five organizations, and as with other management dimensions any framework is arbitrary.

5.1 Structural Issues

Historically, 'Engineering' had been a large, somewhat mechanistic, bureaucratic, and in the best sense, a paternalistic organization, with strong functional and departmental boundaries and relatively disciplined hierarchical reporting and communications. Organizational charts were much in evidence (and much more so that in the other four companies studied), and managers had a high expectation of "knowing where they were". Traditionally there had been many organizational layers with clear 'tier' positions in terms of status and authority.

Organizational co-ordinates of managers in terms of function and hierarchy were thus widely known, and there was a corresponding relative clarity of responsibilities, reporting patterns, linkages and managerial roles. However, because of the sheer size of the company, the many constituent functions and sub-functions, and the corporate reporting structures, (above the company, to Europe, and to the U.S.) the organization was complex.

The structure and the organizational culture appeared to create a strong disposition for hard and soft communications to follow 'acceptable', and usually hierarchical lines. There was an impression that departments had tended to be quasi-autonomous units, so that boundary-crossing had been inhibited, both in day-to-day interchanges, and in the movement of personnel between roles in different functions. Role rotation between functions appeared to have been rare, and had probably contributed to the reinforcement of functional and hierarchical boundaries. Hierarchical structuring was stressed by multi-status symbols, for instance eating facilities. The senior executive dining room with its sombre ambience seemed a different world from the chatter and brightness of the 'other ranks' canteen.

There was an expressed perception by several managers that boundaries had been too firm. A Personnel executive (E-1): "We have been guilty of tight functionally based packets - there is now an increasing need to overcome rigid boundaries". He

explained that increasing role rotation, especially of high potential people, was part of current policy for reducing the "functional watertightness". This reduction of functional definition and the corresponding increase in integration between functions was introduced by several managers, and often associated with I.T. In Supply, E-7 explained that the use of data bases across boundaries, were breaking down functionally based conventions. Similarly, E-15 (Supply) described how currently 'materials inwards' was a separate function from the control of materials after they had entered the production process, so tightness of control of materials was thus lost. Because of the speed and processing power of computer aided intelligence, there was now the possibility of an integrated plant-wide tracking and control of materials and components, and optimising utilisation.

Obviously, previous P.M.M. sub-systems were interconnected - though these connections often were not highly specific in coupling or in time sequencing. On the other hand, one of the strengths (and at times drawbacks) of I.T. is that it forces specificity. Interconnectibility has to be specific in terms of hardware, software and handled data. In particular I.T. forces 'correspondence' of data formats across boundaries. This was well described by E-16, a senior User-System-Planner: "In planning I.T. there has as yet not been enough thought given to the organization as a whole - managers have been far too compartmentalised - they have seen functions in a narrow way and in terms of the end result in their own terms. Hence I.T. developments have been piecemeal. Systems need to be thought out from the very top, based on company objectives. All managers now need a good understanding of data processing, systems design and application - so that systems become an inherent internalised component of management thinking".

The lack of communication and co-ordination across the various departments was confirmed by E-20, a senior Finance manager heavily involved on planning the B.I.G.L. (British Isles General Ledger) system. "We must have an integrated system and there are monthly meetings to keep relevant managers informed. But the company has not done enough training on I.T. and its

implications, nor sufficient job rotation: we are too rigid and compartmentalised. There is a need for a total finance system co-ordinator - a lot of change is required in attitudes and approaches to produce integration". A manager who had a long experience in a sister company repeated similar views, and particularly affirmed deficiencies in liaison between design, manufacturing and office systems, which would have to be overcome as I.T.-based interconnections between these functions developed - "as they must".

Two ideas seem to emerge from these comments: firstly that 'Engineering' had been strongly compartmentalised in terms of communication, and that this had acted against the integrated development of I.T.; and secondly that as the interconnections of I.T. systems between functions increase (and eventually become commonplace), boundaries are decreasing in their latent controlling power.

Another structural aspect of communications is naturally the vertical tiering of the organization, and as mentioned earlier there had been many tiers with strong definition. However, the study revealed a conscious attempt to reduce tiers - "to flatten the structure" (E-1). In fact in the Commercial Division, one layer of general foremen (actually middle-managers) had gone completely. Examples of fewer tiers were quoted in Material Scheduling (E-7), Marketing (E-8), Supply (E-15), and in Finance (E-19). Tier reduction was associated with the considerable shrinkage in the total labour force over the previous ten years, but, to an extent, that reduction was interwoven with productivity increases partly due to information technology usage.

In many comments I.T. structural change and increased organizational transparency were associated: "Top executives can now more easily monitor what is happening at operational levels - because of I.T. - the 'bull' doesn't cover up so much". (E-7). In Accounting E-18 commented: "The I.T. system has to be specific - and this forces the organization to be more disciplined - the organizational fog is decreasing - and, incidentally, that discipline extends outside our company to our

vendors. They also have to be precise in their timing, in paperwork, and in numbers". The same point was made by E-10 in Supply: "My job is less a day-to-day jungle - the data is clearer - the 'bull' is less - I am more able to know about, and to control suppliers, because of I.T.". Current states of purchasing, compared with budgeted figures, were immediately and starkly brought to the attention of senior managers by the I.T. network - "there is less room for fudging - my explanations have to be on the ball". (E-10).

Here is another example of the 'field effect' of I.T.: several characteristics - cleaner, more specific data; increased data accessibility via terminal networks; and data timeliness - impinging on and changing boundary tightness, number of tiers, function integration and organizational transparency. Data seem to be becoming available to a wider audience - for instance there was a definite perception amongst managers that access of subordinates to information was increasing.

5.2 Data Issues

Because of the increasing specificity of information required by I.T.-driven systems, managers often claimed improved comprehensibility, though this was tempered by the excess of data produced by computers in printed form, and sometimes by managers not liking particular formats of data presentation. Managers widely felt that the quantity of information they were using in their roles had increased in recent years. However, virtually all managers claimed the usefulness of printed information had increased due to the ease and speed with which copy was produced on modern printers.

Data value depends, amongst other factors, on timeliness, and comments from managers in comparing previous P.M.M. systems with I.T. systems, threw up paradoxes. In P.M.M. arrangements the system and its data were often 'owned' by particular departments, and provided rapid access to 'accepted' personnel, but allowed only difficult and slow access to managers (and personnel) outside that department's boundaries. I.T. systems, while at first overlaying existing P.M.M. processes, were

designed by M.I.S. staff from outside the department and thus incorporated more interconnections with other company sub-systems.

Nevertheless, early computer-based systems were often quoted as being unfriendly, over-formal, and too compartmentalised. Later systems, especially as cross-department data-bases are spreading, were regarded as allowing more timely, and better formatted data to be accessed. E-7 (Material Scheduling) for instance: "Data is clearer and more available, the fog index is less - senior managers are much better informed than previously - and therefore there is more emphasis on exceptions".

Part of the reduction in organizational fuzziness quoted by several managers was associated with speed of I.T. transactions. Time delays in obtaining relevant information seemed to them to be decreasing - statistics often being available in days instead of weeks. In Marketing "very fast communication with our dealers is worth an extra 1% of market share" according to E-18. For the previous two years dealers had been able to log directly into the company system to obtain current status of orders placed, via a computer-operated voice response. Currently the system was handling 28,000 transactions a day, dramatically reducing telephone calls, and incidentally had reduced a marketing section from fifteen to two clerks.

Within the organization the average number of electronic mail messages sent by managers per day was .5, and only 25% of managers questioned had e-mail facility, although a Director (E-13) regarded it as an important agent for improving communications.

In fact, at the time of this study most I.T. systems were used in 'operational' settings, (HEAD - level 4), and therefore terminals and screens were handled mostly by clerical staff, and not directly by managers. Most managers were not skilled in terminal use, and this was undoubtedly inhibiting I.T. diffusion.

5.3 Oral Communication

It was plain that oral communication remained dominant in managers' work and varied enormously depending on personalities, functions, number of staff, and the current extent of I.T. use. Moreover, managers widely stated they were spending more time talking with staff than previously. Although this might have been wishful thinking, certainly there was no evidence in 'Engineering' that oral communication was decreasing as I.T. was increasing.

5.4 Summary

Communications at 'Engineering' operates within relatively disciplined procedures, strong departmental boundaries, and a many-tiered complex hierarchy. All this is of course consonant with the existing culture.

The development and spread of I.T. is allowing easier access to data and so increasing organizational transparency. Boundaries are weakening, and specificity of ownership of data, and sub-systems, previously based on departments and on particular managers, is reducing.

Comprehendability of data appears to improve with I.T., but information overload seems to be occurring in some situations.

In spite of the growth of use of I.T. oral communication continues to be of major importance. Indeed managers claimed widely that their consultations with their subordinates and superordinates had increased in recent years.

6. MANAGERS AND DECISION MAKING

The interwoven nature of managerial work stressed in Chapter Two is especially apparent in the arena of decisions. At 'Engineering', and as will be seen, in the other four companies also, managers found great difficulty in defining and explaining their involvement in decision making. While 'people issues' and

'communication', the other two components of managers' work studied in this research, had a certain form and substantiality, decisions were more ephemeral, if minor, or often blurred by consultations and committees, if major. Further, information processes and decision processes were always entwined: the same I.T. factors influenced both.

As has already emerged, 'Engineering' had a traditional, 'mechanistic' organizational culture, with longstanding high definition of processes, boundaries and hierarchy. Authority and responsibilities were likewise relatively well-defined - indeed managers from a sister company regarded 'Engineering' as "staid", (E-3, for instance). Initiative taking was not encouraged. On the contrary the 'heads below the parapet' dictum was often implied in comments, if not stated outright. "They are scared of initiative taking ... " opined E-18 from the sister company.

Although computing had been spreading for two decades and was inherent in the decision apparatus, it seems to have merged with the existing conservative culture. Managers commonly perceived this main-frame computing as having slight effects on the way they managed.

The recent developments and spread of I.T. is of a different nature. The several generic characteristics of the technology discussed in Chapter Two, and their many implications, appear to combine in a 'field effect' acting on the management culture. This is specially so in decision making.

Data and decision mechanisms are less inhibited by arbitrary functional boundaries as data bases integrate sub-systems previously isolated in departments. E-10 (Purchasing): "Communication between departments is vastly improved via screens". E-1 (Personnel): "(The new system) will allow each (functional) department to access their own personnel data from the (common) data base".

Similarly, the computer system formats and presents information, derived from operational levels, to senior executives quickly

and continuously. This is now well known by lower and middle managers and undoubtedly conditions their thinking about decisions. E-10 again: "The clarity and speed of data produces pressure to take decisions faster, and this enforces delegation". The loss of 'ownership' of data, and the ability to fudge, was not lost on middle managers either. E-7: "Top managers can now more easily monitor what is happening ... The 'bull' doesn't cover up so much", - a remark echoed by several managers.

Another dimension of this changing culture is the reduction of routine personnel administration in operational departments as the number of staff fall due to computerisation. It seems also that the 'monitoring of staff' role of managers decreases as professionalism and sophistication of subordinates increases. As was suggested earlier, where advanced I.T. is in use, non-management roles become more like management roles. Thus the many minor administrative decisions of managers are absorbed into the system, or taken by juniors, or vanish.

Thus I.T. is softening boundaries, integrating functions, increasing pace, responsiveness and transparency - all related to decision making and all dissonant with the extant culture.

7. SUMMARY OF I.T. EFFECTS

At the outset it is important to emphasise the great variety in I.T. applications at 'Engineering' in mode, extent and sophistication. In some departments a third generation system is being used by staff highly experienced in the technology. In others I.T. is entirely novel. It is clear also that I.T. is producing many separate, but linked, effects on various aspects of management work. The total culture is undergoing a significant transition, though at this intermediate stage outcomes vary from manager to manager.

There has been no revolution. Rather, newer, more effective, more integrated, faster systems have been evolving and replacing previous paper-based arrangements or computer 'packages' of an

earlier marque. The principal source of system design and motivation for I.T. implementation lies with the experts in Management Information Services (M.I.S.). Priorities for applications are set by the M.I.S. committee (chaired by the Finance Director), though most user-managers perceived the spread of I.T. to be mainly tactical. User-designer tensions discussed by FRIEDMAN (1983) were evident, especially as the speed of development and fluidity of I.T. are rather dissonant with the prevailing culture and practices.

The parent corporation seems to have given little weight to the technology until perhaps 1980. Since then there has been a distinct increase in corporate attention to robotics, automation and systems. Even so, in 'Engineering', managers generally considered the company was lagging behind the 'industry norm' in terms of I.T. Moreover, training and preparation of managers for new systems and equipment has been slight, and in many departments, entirely absent.

'Engineering' is large, and organizationally complex with a profusion of departments, functions, and separate offices and shop floor facilities. The company is procedurally bureaucratic, slow moving, even 'staid' in the eyes of managers coming in from a sister company.

Head-count pressure from the U.S. is strong and regarded as counter-productive by many managers. Nevertheless a policy for reducing staff by 5% per annum is in place.

Computer applications have been diffusing for more than 20 years and at the time of this study over 100 programs or systems were in place. In the way NOLAN (1979) has described, initially applications were in high-volume, simple transactions such as wages calculations but have gradually extended into more complex activities in most functions. So managers have had a gradually increasing exposure to computer practices. However, it is only in the last three or four years that I.T. has quite suddenly become a major issue for many managers, as terminals, word processors and personal computers become much more available.

The prime motive for I.T. usage quoted by managers is reduction of personnel - the "cost saving" phase of NOLAN. In the more advanced areas of I.T. use the advantages of timeliness, clarity, accessibility and speed of transmission of data were more often quoted by managers - the "added value" phase.

However, virtually all managers claimed their involvement in and knowledge of computers and systems had increased substantially in recent years.

As I.T. enters a department staff numbers decrease, while the proportion of skilled and professional people increase. Hierarchical and functional structures tend to become less constraining, with data and managers able to cross boundaries more easily. Integration between departments tends to be improved and the total number of sub-systems to fall. Managers often felt they now had a less parochial view of company affairs, an advantage in their eyes.

The implications for managers' roles are neither clear-cut or easily identifiable. Certainly managers are spending more time on systems analysis, design and management than previously. About a quarter of the group had a terminal or a personal computer in their own offices, though the average usage was only 16 minutes per day. (Electronic mail was hardly used at all).

It is important to distinguish between I.T. effects on systems, and effects on roles. For instance there appears to be a tightening of disciplines in terms of data formats, routing and timing, coupled with improved data clarity and reporting procedures. Also managers approved of the increased access to data and to computer 'packages' for data manipulation and interrogation. On the other hand, managers often expressed uncertainties as organizational transparency increased and as their ownership and control of data decreased.

The greater access of subordinate staff to data, and their increase in management-like skills of initiative taking, flexibility and information handling requires a different form of management. Team building and team relationships become

significant as managers can rely less on traditional hierarchical styles.

Routine, repetitive administrative role elements seem to be decreasing. Managers saw themselves spending more time on 'people' issues, being less formal, and having a longer time frame. They thought they were occupied less on tactical and more on strategic matters. A possible confirmation of this is their belief that communication with their senior managers is improved.

Decision mechanisms are less inhibited by arbitrary procedures and boundaries, though increased organizational transparency undoubtedly is conditioning managers.

The argument introduced in Chapter Two that I.T. is a pervasive technology is certainly borne out in 'Engineering'. It is now a major influence on the ideas and practices of managers, and is producing an accelerating rate of change.

'HARDWEAR'

1. THE COMPANY : Medium scale; manufacturing and marketing of precision engineering components; subsidiary of Continental-based multinational.

1.1 History

In 1905 a young maintenance engineer at a European textile plant was having serious problems with certain imported engineering components resulting in frequent and expensive stoppages. He put before his Directors a proposal to manufacture the items in his own works; this was supported. After a short research and design phase a separate company was formed in 1907. From this modest start, a world-wide corporation developed; the British subsidiary, 'Hardwear' being launched in 1910.

From then until the mid 1970s an eventful history of development and expansion followed, with increasing range of products, output, number of employees and turnover.

By the 1950s U.K. production was on two locations, 2.5 miles apart, the newest being a 44 acres green field site, equipped with sports pavilion, playing fields and social centre. New production facilities to meet the increased demand for products, especially from the motor industry, were inaugurated, and in 1962 a new factory in Scotland came on stream. All this was paralleled by equivalent extensions of engineering developments, marketing and personnel functions.

It was in the mid 1960s that cutbacks in demand began to appear, though total staff continued to expand to a peak in 1970 of 5,807. Competition, especially from Japan, grew intense and plans for reducing capacity were made. In 1977 and 1979 respectively, the original factory and the Scottish unit were closed. There were financial losses in seven out of eight years from 1976 to 1983, although a profit was made in 1984.

Figure 4.6 shows employment, turnover and profit/loss statistics.

Figure 4.6 Employees, Turnover, Profit

Average Number of Employees per Year		Total Sales Value (£000s)	Net Profit (Loss) after Taxes (£000s)
Year	Number		
1968	5,294	17,846	1,101
1969	5,610	19,619	976
1970	5,807*	22,191	755
1971	5,486	23,686	1,777
1972	5,230	24,115	1,032
1973	5,110	27,891	1,039
1974	5,108	35,439	1,531
1975	4,934	43,062	1,463
1976	4,160	46,990	(1,099)
1977	3,826	55,214	(4,167)
1978	3,440	58,879	(4,980)
1979	2,627	65,162	(5,781)
1980	2,532	71,781	23
1981	2,368	69,285	(2,021)
1982	2,046	69,527	(2,792)
1983	1,596	66,370	(1,526)
1984	1,122	69,281	307

* highest

1.2 Products

'Hardware's products are high precision but mass produced from special quality steel, using automated machining and transfer facilities: total machining time for a standard product being now a little over one minute. Quality control is crucial and much of it is accomplished automatically. The total world-wide product range covers 25,000 variants, but a corporate rationalisation scheme allocated a small, but important, product segment to 'Hardware', which now manufactures 4% of the corporation's European output, compared with Germany 38%, Italy 30%, Sweden 17% and France 11%.

Although the product range has modified over the years as has the detail sophistication of the product, the fundamental design

remains substantially the same. In fact, a handmade component of 1910 appears remarkably similar to the article today, though the latter is produced on a highly automated production line.

1.3 Organization

The parent corporation appears to have a major influence over the broad financial, and product range, parameters, but within this framework, the local Directors have high autonomy. Nevertheless, policy and strategy from the corporation (known generally as 'Group') plainly set the context at 'Hardwear'.

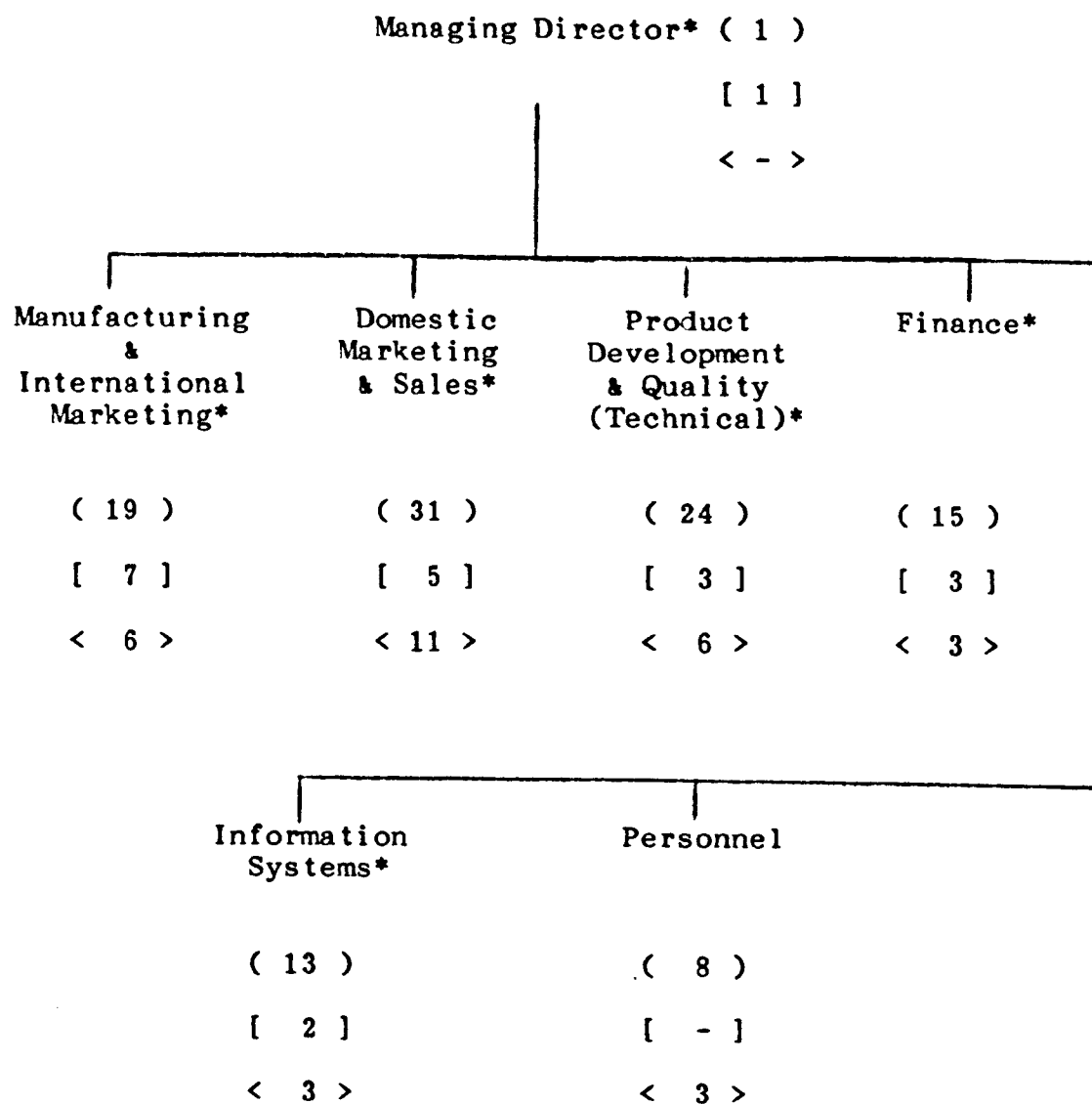
The broad pattern of organization is illustrated in Figure 4.7. As the M.D. emphasised, the company had two tasks: firstly to market, and to supply the complete corporate range to U.K. customers, and secondly, to manufacture a specific product segment for marketing (by sister companies) throughout the world. This twin purpose leads to the linking of International Marketing with Manufacturing, and the clear separation of 'Domestic Marketing' which acts as an arm of the corporate sales function.

All 'Hardwear' departments had 'dotted-line' responsibilities to Group H.Q. Many computer-driven systems have been in place for a decade or more, and there is a well established 'Information Systems' (I.S.) department headed by a Director (in contrast to the 'Engineering' case where M.I.S. was within the Finance function, and not led by a Director).

1.4 The Study

Twenty-one interviews were carried out: their distribution by function and tier is shown in Figure 4.8. Thirteen of these managers returned the questionnaire.

Figure 4.7 Organization and Pattern of Interviews and
Questionnaires by function



(24) = Numbers of managers in that function
 (tiers 1 to 4) (Some of these are supervisors).

[3] = Number of interviews carried out.

< 6 > = Number of questionnaires completed.

* = Interviewed Director

Figure 4.8

Pattern of Interviewed Managers function
and by tier

Function	Interviewed Managers Tiers				Totals
	1	2	3	4	
M.D.	1				1
Manufacturing		1	3	3	7
Marketing		1	3	1	5
Technical/ Engineering		1	1	1	3
Finance		1	2		3
Information Systems		1	1		2
Personal, Industrial Relations & Secretariate					0
TOTALS	1	5	10	5	21

Notes:

1. The actual 'organizational chart' functions have been used here. In practice this was often a matter of organizational convenience: for instance the work of a particular person might be mostly not of that functional character.
2. In addition to these interviews, the researcher has spent approximately two weeks talking informally with managers, and observing the practices amongst managers.
3. Below tiers 1 and 2, tier level is not a good guide to level of responsibility and authority: factory managers, for example, nominally at level 4, carry a heavy responsibility, in strenuous conditions, perhaps equivalent to some tier 3 managers in other functions. Some people with strong technical expertise (for instance in computing) were at tier 3, although their managerial, or 'people', responsibilities, were relatively slight.

1.5 Summary

'Hardwear' with a current labour force of 1,100, and a turnover of £70,000,000, is a relatively small subsidiary of a European multi-national, producing and marketing sophisticated engineering products for world distribution. Due to reducing demand, strong competition and against a backcloth of unfavourable results, the company had just completed a phase of rationalisation of product and facilities.

2. I.T. IMPLEMENTATION

2.1 The I.T. Culture

The parent company of 'Hardwear' is an international corporation with some eighty plants, 170 companies and more than 50,000 employees. It is the world's biggest supplier of its product type, providing a fifth of global requirements. Vertical integration within the corporation is strong: from extraction of raw material, manufacturing machine tools, to production of final products. The Group has substantial research and development facilities, particularly for product and process development.

The market for the product has been decreasing for three years, (in 1983 by 5% in Europe), and employment in the industry has decreased around 15% in the past four years. Manufacturing rationalisation and restructuring, in order to optimise volumes of components at each plant has been taking place. 'Hardwear' has been involved in this process.

'Group' is a powerful determinant of strategy for 'Hardwear', and was mentioned often by interviewed managers. There is, (according to the M.D.) a written down group corporate strategy for information technology, covering commonality and compatibility of systems, common data bases, I.T. in manufacturing, scientific computing, inventory logistics, international planning and customer data links. However, no

other manager claimed to have seen a written strategy for I.T., and nearly half the interviewed managers thought there was no plan for I.T.

The corporation also has a strategy of working towards plants of less than 500 employees, to gain industrial relations advantages, especially now that the economic advantages of large production units is diminishing because of technical advances in automation and computer control. There was corporate advantage in having a factory in the U.K., and with only 4% of the European total production in Britain, it was widely hinted that it would now be politically difficult for the corporation to reduce further the factory's output. This situation, plus the fact that 'Hardware's segment of the product range was considered to be 'mainstream', contributed to a fairly optimistic mood amongst managers.

Within 'Hardware' I.T. strategy was claimed to be determined by the local Directors in monthly meetings though according to two Directors H-7 and H-3 the discussion had a mostly technical orientation. Priority setting and checking progress of systems developments were the main topics. There was no written down programme of intended implementations of equipment or systems, nor was there evidence of deep consideration at Board level of organizational implications. Personnel and organizational issues had been discussed peripherally, but training appears to have not been given strong emphasis.

With the exception of the Director of Information Systems, no great enthusiasm for, or knowledge of, I.T. was expressed. Indeed one Director (H-3) said no Directors were "that interested" in the subject.

Amongst senior managers who were involved in systems applications, surprise was expressed at the relative lack of understanding amongst their senior colleagues of the strategic importance of I.T., and how slight was the effort to increase knowledge of the technology and its implications.

What emerges then is a policy of responding to tactical pressures, with differential evolution in the several functions. The original company emphasis was on production and engineering, yet manufacturing management had been the least interested in the potential of I.T., possibly partly because of the dominance of Group in this function and the anticipation of a Group designed integrated computer-driven manufacturing system. This system, to be installed by 1987, was expected to link several activities associated with manufacturing.

Because of the shrinking market, and increased competition, the company had become much more customer orientated, and marketing was widely regarded as the leading function in using computers and telecommunications. In that department there was a systems steering committee chaired by the Sales Director, and the strategic potential of the technology seemed well understood, particularly in improving customer data links with 'Hardware'.

The Finance department had been slow into the I.T. field but a two-year application programme was now in place. In the Engineering department use of a minicomputer was evolving to improve technical specifications for customers, though again this development appeared to be more tactical than proactive strategy.

There was a high consensus, then, that the strategic approach to information technology was weak, or unknown, that developments in the separate functions were largely tactical, and that the longer term implications of I.T. on the organization had not been thought through. Also, the authority of Group on these issues emerged often, with the sense that local initiatives might be being suppressed.

2.2 I.T. Applications

Although the company first acquired a computer in 1963, and so can be regarded as well experienced in electronic data processing, the major part of the organization's activities had

continued relatively untouched by computing until the last three or four years. There was a long tradition of precision mechanical engineering, and naturally there existed a corpus of knowledge and experience in that field, but electronics and computer science had not been a forte. Indeed, except for the Director of Information Services, who was expert, not one of the five Directors interviewed claimed more than an 'awareness' of information technology, even though they were particularly well qualified and experienced in their own fields. Similarly, fewer than half of the managers interviewed professed knowledge of I.T. beyond 'awareness'.

2.2.1 Finance

Implementation had proceeded, not in a planned fashion, but according to the various levels of knowledge of applications, imagination and enthusiasm amongst managers. Paradoxically in Finance, where computer involvement had started twenty years earlier, there had been little zeal until recently, when a Finance Systems Administrative Manager was appointed (late in 1983) with the brief "to get systems into Finance". The department was widely regarded in the company as lagging behind, (though not as much as manufacturing) but there was now a plan for I.T. applications covering general ledger, budget index, purchase variances, stock movements, accounts payable, customer invoice, archiving, decision support systems, and microfilming. Although pressure for these developments was felt from senior executives, according to H-3: "the subject is too complicated for them to know what they want. I.T. does not seem to have had as much impact in Finance, in terms of return on investment, and anyway accountants are 'introverted' and not too aware of the benefits of I.T." This relative lack of enthusiasm for I.T. in Finance was echoed by a young (29) manager: "Not enough initiatives are taken seriously here - it is fairly staid. When I joined the company three years ago I was ahead on I.T., but my knowledge has now disappeared because of disuse, and partly because there is no training. We have looked at all the possibilities for systems in Finance, but it has been difficult

to show cost and head count advantages".

This manager, responsible for eighteen staff, used a VDU or a PC for 45 minutes a day, and was involved for three hours a week on systems issues. "We are far more dependent on computer records: it would be impossible now to maintain records with current staff levels without computerised assistance".

In the area of manufacturing accounts much of the routine work had been computerised: both standard costing and inventory systems had been on the main-frame for fifteen years. However, the advent of the personal computer was apparently "a major change - and is causing role change because of release of initiative" according to H-15. The Finance department then had a longstanding familiarity with computers, with little enthusiasm for exploring new applications, until the previous year or so, following the introduction of ten personal micro-computers.

2.2.2 Technical

'Hardware' is essentially a technological company with many skilled engineers dealing with product and process development, and offering applications assistance to customers. Marketing and Technical are therefore strongly linked, and Computer-Aided-Engineering and Computer-Aided-Design are being developed locally, and at H.Q. on the Continent.

Managers in 'Technical' emphasised the need for the company to be seen by customers as using 'State of the Art' computer technology. There was also a pressure for the company to take greater responsibility for product quality and specification, and as competition was tough, the exactitude of technical specifications were becoming tighter. Much of the technical operation of the company called for matching products to application specifications, and seemed to be suited to computer systems. In fact, a minicomputer, independent of Information Services (I.S.), had been used for five years for C.A.E. but

only two staff were deeply implicated in the activity. The manager responsible, using a VDU twenty hours per week, was entirely immersed in computer-based-data issues, but he felt the centrality of such systems in Technical had not been sufficiently grasped by management or by staff - partly he thought because of lack of appropriate education and training.

2.2.3 Manufacturing

Manufacturing was the original emphasis of the company, yet amongst the interviewed group, was widely regarded as slow in taking up the technology - (note the similarity with the 'Engineering' case).

Two explanations were evinced for this. The first was the reduction of production capacity, including the closure of two factories in the late 1970s. The second was that local developments of integrated manufacturing had been abandoned in favour of a highly sophisticated Group scheme, which was taking much longer to come on stream than anticipated. This scheme will integrate production scheduling, inventory control, purchasing, engineering specification, and control of production equipment.

There was also an expectation that, to provide rapid response to customers, without high warehousing costs, short production runs would be necessary, and this could only be accomplished using computer based operations. For instance 500,000 tool pieces were available, and selecting and fitting tools relevant to the production run (related to product type and size), was a major cost in time and money. Only by computer-aided-arrangements could this problem be solved.

Thus managers had an appreciation of the potential of I.T. to solve problems, and to create implications for changing what had been a relatively static production process for many years.

I.T. was already being used in a wage payment incentive scheme,

for stores records and inventory control, quality sensing, machine tool control, and for CAD/CAM. Data formats were criticised at length by factory managers, but as at 'Engineering', it was felt that the liaison between user-departments, and 'Information Services', needed strengthening.

2.2.4 Marketing

By general acclaim it was Marketing that was moving most quickly into I.T.-based operation. The Managing Director: "I.T. is a major opportunity for Marketing. We want to have strong links with customers by I.T., so they can get price and delivery from us. A computer link is as important as a salesman, and more effective for established business". The Marketing Director: "I.T. is the key to our future; if we don't take advantage of it, there are problems ahead. It is vital to our success - product differences between us and our competitors are decreasing, therefore the back-up services become more important. Thus we are selling services, and rapidity of data handling is at the centre of this".

There was a systems steering committee chaired by the Marketing Director, and attended by the company's Director of Information Services - evidence of its priority in this function.

Both in sales administration, and in 'Distribution', there was evidence of considerable emphasis on I.T. operation. H-16, responsible for customer enquiries and order processing, felt that 90% of his job was in some way I.T. related. He and his six subordinates all used VDUs continuously, and he was sure the operation "could no longer be carried out without a computer". As will be seen elsewhere, there is a point along the complexity, and rapidity-of-response dimensions, at which the option to operate without a computer (in a particular application) disappears.

In the Distribution department, including despatch control from the warehouse, a sophisticated system (I.C.S.S.) designed by

Group, covered 99% of requirements of administration, allocation, despatch and invoicing. The system had reduced time from receipt of orders to despatch from six weeks to two and a half days, and it provided customers with useful information which they previously did not receive. This office had eight VDUs each operated by an area (geographical) controller totally responsible for specific customers. In addition three terminals were devoted to stock queries and warehouse control. The changes in staff against volume of transactions were:

	<u>Turnover (Units)</u>	<u>Office Staff</u>	<u>Warehouse Staff</u>	<u>Total Staff</u>
1981	100	25	36	61
1984	79	13	22	35

This manager himself spent 60 minutes a day on a terminal, and about five hours a week on systems design and modification.

Before installation of the I.C.S.S. system, packing and despatch had been prioritised by warehouse staff, shuffling requirements depending on miscellaneous pressures from customers and the sales office. With I.C.S.S. customer priority was set by office staff and the system decided which components were stacked where in the warehouse. The effect was a steady reduction in staff, and warehouse overtime had virtually been eliminated.

Here was an example of decision making moving from one locus to another, with some decisions being taken by machine.

2.2.5 Information Services (I.S.)

Overall the company, with an IBM 3083 B X 1, driving 150 terminals, two minicomputers, fifteen PCs (a total capital investment of £2.5m) was considered by the Director of I.S. to be in the top 20%, but not in the top 10%, of companies in terms of computer applications. There were no developments in local-area-networks, management work stations, robotics or Flexible-

Manufacturing-Systems.

Proposals for I.T. applications had to prove viability, receive support from the Director of M.I.S., and generally by the M.I.S. committee, before being approved by the M.D. However, several managers expressed the difficulties and complexities of proving the return on proposed I.T. applications. "The real reasons for applications are multi-dimensional, and not easily analysable, or understandable. It has to be entrepreneurship", was the view of H-2 in Marketing. "I don't see how you can produce a total justification for I.T. - it is partly improved specification, partly speed, but it is also to demonstrate to our customers that we are in the forefront of technology" - H-5 in Technical. There was often more than a hint that accountants were not familiar enough with the potential of the technology. Post-event financial analysis of schemes were rare: apparently by the time the system was in, debugged and operating, so many factors had altered, that the original justifications were often not meaningful.

Implementation then had proceeded in a patchy fashion, encouraged by the Central I.S. department, and with stronger support from the Board of Directors in the last two or three years. Little preparation of staff or managers in I.T. applications or implications had taken place, and many managers confirmed their lack of knowledge of the systems field. Group was designing and propagating large scale new systems, and to an extent the impression was gained that this had an inhibiting effect on local initiatives by managers. Undoubtedly, the pace and extent of I.T. developments and take up was dependent on the knowledge of I.T., and the vision and imagination, of senior managers in the different functions, always conditioned by the unfavourable financial results of 'Hardwear' over the last several years.

Much of the character of implementation in 'Hardwear' thus has similarities with that in 'Engineering': tactical, patchy diffusion dependent on local enthusiasms and knowledge,

producing differentiated implications across the company, against a strong commitment to maintaining the status quo in some departments.

3. THE CHARACTER OF MANAGERS' WORK

3.1 I.T. Involvement of Managers.

As described in the Methods chapter, the managers studied were divided into three groups: systems/computer specialists (A), of which there were four; managers implicated in I.T. activities (B/C), and managers little involved, or not involved, in I.T. based work (D). Each of the latter two groups was about the same size: in terms of questionnaires returned: eleven B/C's, twelve D's; interviewed group sizes: ten B/C's, nine D's. The systems specialists were entirely immersed in I.T. activities and issues, and they provided a rich source of data on the applications of I.T. and on implications for managers. The report here looks at the roles and activities of managers with particular references to the differences and commonalities discovered in the two manager groups (B/C's and D's).

The pattern of interviews and returned questionnaires by tier and by function is shown in Figure 4.9.

Figure 4.9 Pattern of Questionnaires and Interviews
by Tier and by Function

a.	<u>Tier</u>	<u>Questionnaires</u>			<u>Interviews</u>		
		A	B/C	D	A	B/C	D
	1 & 2	1	1	1	1	1	4
	3	3	7	4	1	6	3
	4	0	3	7	0	3	2
	TOTALS	4	11	12	2	10	9

27 questionnaires

(15 from non interviewed managers, 12 from interviewed managers).

Total group = 36 managers

b.	<u>Function</u>	<u>Questionnaires</u>				<u>Interviews</u>			
		Tier				Tier			
		1/2	3	4	Total	1/2	3	4	Total
	M.D.	-	-	-	-	1	-	-	1
	Finance	-	2	1	3	1	3	-	4
	Technical	-	-	5	5	1	-	1	2
	Manufacturing	-	2	1	3	1	3	3	7
	Marketing	1	5	3	9	1	4	-	5
	Systems	1	3	-	4	1	1	-	2
	Personnel	1	2	-	3	-	-	-	-
	TOTALS	2	14	10	27	6	11	4	21

c.	<u>Function</u>	<u>Questionnaires</u>				<u>Interviews</u>			
		I.T. Involvement*							
		A	B/C	D	Total	A	B/C	D	Total
	M.D.	-	-	-	-	-	-	-	-
	Finance	-	3	-	-	-	3	1	4
	Technical	-	1	4	5	-	1	1	2
	Manufacturing	-	-	3	3	-	2	5	7
	Marketing	-	7	2	9	-	4	1	5
	Systems	4	-	-	4	2	-	-	2
	Personnel	-	-	3	3	-	-	-	-
	TOTALS	4	11	12	27	2	10	9	21

* Involvement primarily discriminated on time spent on systems issues, on direct use of terminals or personal computers, on electronic mail usage, and on apparent amount of interaction with computer produced data.

The split between B/C and D managers in the total group approximately reflected the amount of apparent involvement in I.T. in the functions. (Note: The average age of the B/C group was 38 and for the D group 46).

The B/C group were clearly aware of being in a dynamic situation. Part of this was due to the transition from paper-manual-mental (P.M.M.), to computer-based systems. Part seemed to be an intrinsic quality of I.T. involvement.

Figure 4.10

I.T. Involvement of Managers

	<u>B/C</u>	<u>D</u>
VDU in office: per manager	.4	0
Personal Computer: per manager	.2	0
Number of packages used daily	1.8	.2
Hours/week on systems issues	3.1 to 5.4*	.8
Minutes/day on terminal or PC	59 to 89*	3
Electronic messages sent/day	.75	0

* includes two managers very highly involved in I.T.

For B/C managers, I.T. had become a major focus: 70% of this group felt it was the source of the biggest changes in the company for years. Information gathering, analysis and dissemination, and involvement in computer-driven systems, and knowledge of such systems, were all claimed by these managers to have increased. The recognition that much 'office-work' is centred upon data assembly, and therefore is eminently suitable for computer-assistance, surfaced in a number of interviews, and some managers were entirely immersed in such activities. H-3 (Finance), spent virtually all his time on systems analysis and design. "Without computerised assistance, it would not be possible to gain data rapidly enough to be useful", H-19, explained.

Within the Technical function there was a stark split between the few professionals (including two managers) using I.T., and those mostly 'traditional' engineers, who were not. The former were patently totally involved in I.T.-based analysis, design, and use of data bases, with great enthusiasm.

This differentiation between 'involved' and 'not-involved' managers was again apparent in Manufacturing, within which one unit, 'Industrial Engineering', was currently energetically

engaged in many aspects of I.T. systems. The manager in charge, originally with a department of fourteen staff, now had only seven, but all were highly skilled, and five were trained to use PCs and computer packages. Likewise in 'Production and Inventory Control', the manager was preparing for the introduction of the expected integrated manufacturing system, and much aware of the changing nature of his job: "I have an increased horizon with regard to information - rapid data movement is paramount - my job is more and more about managing data and decisions. I ask myself, with less people, what is a manager?". (H-4).

The D group of managers (in all functions) saw themselves in a more stable situation - only 40% of these people saw I.T. as a major source of change. However, even though their direct I.T. involvement was much lower than the B/C group, there was an evident influence of computers and I.T. systems upon their roles, and upon their view of the organization and the future. Most anticipated considerable changes within the following three to five years. H-13, a personnel manager: "The amount of useful meaningful succinct information available to me as a result of I.T. has been disappointing so far, but I expect great things in the future, particularly in data retrieval".

3.2 Pace

It was in the Marketing function that the immediate impact of I.T. was most apparent. From the Director down, there was a common assumption that I.T. was now quintessential, that it offered major competitive advantages, and that it should be implemented as fast as possible. There was widespread use of computer analysis, transaction processing, and electronic communications throughout the function, coupled with a feeling of fast response, and pace. H-6: "Accurate information is available quickly - we are able to respond to customers quickly and accurately". In Sales Administration the manager said 90% of his job was now I.T.-systems orientated - each of his six supervisors had a well used terminal on his desk. "Most

customers are now placing orders over electronic links, and I can monitor what orders have come in. The job is a frantic activity ... we have to react quickly there and then ... we are having to be more adept in management roles at sorting out systems". A similar heavy I.T. emphasis was obvious in 'Distribution' (another department of Marketing) with the manager involved in ongoing system design with his equivalents at other plants on the Continent, using electronic links. The role of H-2, an enthusiastic 'champion' of I.T., seemed to be key to the developments in Marketing.

3.3 Fragmentation

All the studied managers appeared to have fragmented jobs, with brief activity duration, and little time for reflection. The 'I.T.-involved' group seemed to have less routines, and an increase in proactivity and responsiveness. There was an impression that a linkage exists between the degree of routine paper-manual-mental processes of their staff, and the degree of routine in their own roles. Managers frequently believed I.T. absorbed the routine department jobs. H-15 (Finance): "The routine jobs have been computerised". HQ-14 (Systems): "The routine element of my department's work has reduced considerably". H-16 (Marketing): "VDUs have taken away the drudgery from staff jobs - they can get on with jobs that really matter - taking decisions - getting orders". Both subordinate and managers' jobs were perceived by managers as increasing in proactivity.

3.4 Boundaries

I.T. involvement seemed also to be associated with crossing functional boundaries. The Managing Director explained that technology was making the organization "more complex ... many blurred boundaries ... it is only possible to locate the centre of the task ... managers have to take a broader, more integrated view". H-9, a senior executive in Technical: "The impact of I.T. is going across boundaries - managers have more

interfunctional linking".

An example of this is the extension of connections between manufacturing engineers and financial staff, as systems involving parameters of both functions are coming on-line. H-15 (Finance): "We are tapping into data across boundaries, as a standard practice". H-11 (Manufacturing): "The walls between departments are breaking down - Finance have cost controllers actually in the factories now, and factory managers have to work closely with them. Also, these managers have begun to understand their integration with warehouse, and customer transactions because of the cross-function I.T. systems". The Group Integrated-Manufacturing-System coming into use in the following year or two was commonly expected to heavily integrate many manufacturing sub-functions.

3.5 Planning and Time Horizons

As discovered throughout this research, I.T. appeared often to have paradoxical implications. For instance, because I.T. produces useful data rapidly, and because of real time communications, it cues managers to react to present situations, and thus drives out personal and informal planning. A senior financial executive, H-8: "I now get too much instant detail - I'm a fireman at the moment". On the other hand, I.T.-involved managers affirmed that their concern with strategic issues, their focal point in time ahead, and the elements of (formal) planning in their job, had all increased. (In contrast D managers thought these matters had stayed the same or decreased). Part of the reason may have been that increased I.T. systems forced a more coherent analysis of the inter-relationships, and the time-dependancy, of sub-systems, on managers. For instance, it was clear that in both Manufacturing and Marketing, where sophisticated and integrated I.T. schemes were being developed, those involved took a longer, and more proactive, view of the business, than the D group, or even their management seniors.

3.6 Summary

Managers at 'Hardwear', at all levels, perceived I.T. as a major issue. As in 'Engineering', main-frame computing had been used for twenty years. Thus managers were well acquainted with computer produced data.

The spread of terminals and personal computers had been rapid over recent years and over 50% of the interviewed group had one or the other. However, I.T. development was patchy, as was management involvement in computers and systems. In general, managers seemed cautiously optimistic about using the technology.

Boundaries between functions were less a constraint than previously: integration was commonly seen as improved by I.T. usage. Managers often spoke of increased pace, more pro-activity, and little time for reflection. While I.T. may reduce personal planning by its stimulation of immediate responses, managers believed they were taking a longer view of the business.

4. MANAGERS AND PEOPLE

4.1 Numbers of People

The number of people employed at 'Hardwear' had fallen dramatically since 1975, following the international corporate rationalisation of production. Without exception, managers quoted general and specific examples of this reduction. Tier 2 and tier 3 managers consistently cited diminished staffing levels, but some tier 4 managers quoted increases in the numbers of their own subordinates. This confirmed the generalisation, often referred to, of a 'flatter' structure. Instances of reduced staffing brought about directly by increased technology proved difficult to elicit. Plainly the amount of I.T.-based activity was increasing as evidenced throughout 'Hardwear' by

more terminals, computer-driven systems and print-outs, and computer telecommunications. Equally plainly there were widespread examples of greater use of technology being the cause. But other possible causes were quoted, and blurred the picture, no doubt because of the sensitivity of the jobs - technology relationship. Managers throughout the company commonly spoke of anticipated further reduced staffing, usually amongst unskilled, semi-skilled and professionally unqualified personnel.

The Information Systems department with a staff of 42 in 1985, had declined from 75 personnel in 1977. Although several factors contributed to this, the increasing speed and sophistication of the hardware, and the use of later-generation programming techniques, were prime. This was a particular case of more, and higher, technology leading to reduced staff.

Likewise the distribution and warehouse function was another clear example where the installations of I.T. systems had reduced staffing levels by about a quarter (taking into account a 21% drop in turnover in the period; reduction from 61 to 47).

Staff reduction in Manufacturing is shown in Figure 4.11.

Figure 4.11 Staff Reduction in Manufacturing Function

	1980	1985	% Reductions (corrected for changed turnover)
Managers/Supervisors	70	42	38
Professionals	49	27	43
Skilled clerical	37	37	0
Unskilled clerical	21	16	20
Skilled manual	201	98	51
Unskilled manual	1357	453	65

Although some of this reduction could be attributed to product rationalisation, and to the eradication of overstaffing, a proportion was due to increased automation and computer-based controls in the factories.

D (less 'I.T.-involved') managers claimed, on average, that the number of their subordinates was the same as five years ago; the B/C ('more I.T.-involved') group perceived a small fall, while computer specialists reported a 25% fall in their own staff. As I.T. involvement increased so did the tendency to report staff reduction.

Generally the reports were of a greater reduction in the lower skilled people, manual and clerical, so that the proportion of professionally qualified, and skilled personnel, had increased.

In 'Hardware' the altered functional boundaries, plus the movement of managers - usually promotions - made it impossible to determine precisely the changes in personnel in any section over the last five years. However, it was possible to discover the current reporting patterns which are shown in Figure 4.12.

Figure 4.12 Numbers of Staff responsible to Managers

Tier	<u>Numbers of staff reporting directly to manager</u>			<u>Numbers of staff manager responsible for (not directly)</u>		
	Mean	Most* Common Range	Range	Mean	Most* Common Range	Range
2	6.3	3-9	3-9	162	10-100	10-675
3	3.2	2-5	0-8	55	10-20	0-600
4	3.3	0-6	0-11	17	1-6	0-150
Overall	3.4	3-6	0-11			

Note: Occasionally professionals with a 'management' title had no staff reporting to them.

* 80% or more of managers in this range.

Usually then, managers studied had between three and six people reporting directly to them, and responsibility altogether for two to twenty subordinates. By far the largest numbers reporting to managers were in the manufacturing area.

4.2 Skills of People

Amongst all managers there was constant reference to changed and 'increased' skills, the need for more education and training, and the requirement to develop appropriate management style - sometimes termed 'environment', for high technology staff. H-3 (Finance): "There are less people and more machines so technical awareness is increasing - we probably need more education about technology - people are becoming more adaptable, bright and professional". In Technical, H-4: "We now need a higher calibre person - normally with a degree - I.T. has been developing too slowly because of the momentum of the 'old school' - older people". Again, in Manufacturing, H-11 explained that a new breed of production manager was needed, with electronics and systems skills, rather than (people) shop floor skills. "The management of people is decreasing because there are less people, but they are of higher calibre and with higher education. People want more responsibility - the people function is easier" was another comment in Manufacturing (H-7).

A similar story came from both H-2 and H-6 in Marketing: fewer people but higher skills. H-6: "Managers are becoming more professional - there are less staff but their skills are higher ... more flexible ... more independent".

4.3 Management of People

Although reduction in overall staff numbers was patent, managers consistently reported their time on 'people issues' had increased over the last five years - and this was especially so amongst the 'I.T.-involved' managers. The 'management of people' roles and style, of the studied managers, had little detectable consistency. Certainly no manager quoted any company

principles, policy or strategy regarding personnel. Nor was there a clear division of managers into 'old-schoolers and new-schoolers'. Most managers had been with the company many years (commonly more than ten) and the differences of view about staff management appeared to be functionally orientated. As the spread and intensity of use of I.T. was itself functionally differentiated, management 'style' and behaviours, in relation to people were (again) associated with I.T. involvement. This overlaps with communication issues discussed later, but Marketing and Systems managers tended to speak in team, rather than in hierarchical terms, of their subordinates. The 'small business team' concept was being developed in Marketing, with "as much discretion as possible at the salesman level. Because of computer print-outs we can measure the net profitability - sales costs can be charged against revenue - now the salesman has to be responsible", according to H-12. Again in Marketing, H-2: "The boundary between managers and non-managers is blurring. Sales clerks can call up all kinds of information, for instance about our customers - therefore they have more ability to intervene in the (sales) process ... It is very important to give all data to staff". H-16, a tier 4 manager in Marketing: "Everything I do is to motivate my team - particularly by communicating successful activities ... I have a highly motivated team anyway ... they get a kick out of giving good service to customers". And in Distribution, H-20: "One of the reasons we have improved performance is better understanding by staff of objectives and general information on (sales) throughout. Staff used to work blind. Now targets are well known by staff. We have regular staff sessions every three months when we stop everything for two hours - good feedback and good ideas from the staff".

In Manufacturing, where control of machines and quality control had been installed, but where I.T. data systems were relatively unsophisticated, there was also a trend in the same direction. H-11: "Delegation is increasing to my staff; once a system is established it can be handed over to subordinates. There are more colleague relationships between 'boss' and people - the

environment is one of ideas and must not be repressed by the 'boss' system". On the shop-floor there were regular briefing meetings with 40 to 50 employees every fortnight, based on the new bonus system. "People feel they are contributing and see direct relationship with wages. Managers are not used to communicating, and they need to be motivated and trained to communicate". (H-10, a senior executive). This was confirmed by factory manager, H-21: "... lots of consultation - as much consent as possible with work-force has been sought. Quite a change - people are much more willing to go along with well argued propositions. Hardly any disputes ... Consulting people is the way forward".

Training was a continuing theme, both for the managers, and for their staff. Undoubtedly managers thought the diffusion of I.T. based systems was being retarded by lack of management skills, imagination, and appreciation of the potential of the technology. One executive was still surprised at how senior managers did not understand the strategic importance of I.T. and did little to improve their understanding. However, a project was under way to improve management and technical competence throughout the company.

Even so there was anxiety that insufficient training was taking place. H-18 (Manufacturing): "I am not happy about the level of knowledge and skills my staff have - insufficient attention is being paid to training ... and into manpower implications (of I.T.)". A senior executive in Manufacturing: "It is difficult to recruit foremen for sophisticated (production) lines. One of the mistakes I have made is not having sufficient education and training for managers and supervisors - especially technological training". And from a factory manager, H-21: "We don't train people well enough ... no-one in the factory knows anything about computers. We have an obligation to bring everyone in offices, or involved in data, into contact with computers. They must be familiar with work stations and systems. I can't get on with this because I don't have the knowledge or the equipment".

Many of the studied managers were also anxious about their own lack of understanding of I.T. H-4 (Manufacturing): "I need to develop keyboard and computer language skills and would like to visit enlightened companies (for production control) - particularly in Japan and the U.S.". Another factory manager, H-13: "The job is moving towards systems orientation and I can't get to grips with it. I have to know the concepts of systems before I can feel happy with them. There hasn't been time to attend a computer course".

4.4 Summary

'Hardwear' has had a dramatic fall in total manpower over recent years, and while there were several contributing factors, there can be no doubt that I.T. is one cause. Managers had clear perceptions of increased and different skills amongst subordinates with more emphasis on adaptability and professionalism. Differences between 'management' and 'non-management' activities were reducing as a general ambience of initiative taking and flexibility was developing in sections much involved in I.T. use. Managers recognised the need for a 'changed environment' for high technology staff, one component of which is a team approach.

Training was understood as a key requirement in implementing and adapting to sophisticated systems technology.

5. MANAGERS AND COMMUNICATION

All the managers studied at 'Hardwear' universally perceived themselves as heavily involved in information gathering, analysis, and dissemination.

5.1 Structural Issues

As in 'Engineering', there was almost unanimous comment about the ease of boundary crossing, and an increase in organizational

transparency, both across functions, and vertically, brought about by I.T. The Managing Director especially emphasised this increased organizational integration, and the consequent requirement for managers "to understand the whole picture". This illustrates another apparent characteristic of I.T. systems - the "positive feed-back loop". Holistic management is only possible because of sophisticated I.T. networking allowing timely data and wide accessibility. But because of the latter, holistic management becomes necessary.

Many comments were made about increased visibility - often associated with increased vulnerability of managers. Phrases such as "the fog is less" and "managers are more exposed" were common. H-2 (Marketing) gives an example: "There is a lot more visibility of operational levels ... staff now chase answers because the questions are visible to senior managers ... it is difficult to hide ... managers are out in the open and this is changing the kind of manager who is competent". Similarly in Finance, H-3: "People still try to protect their areas but data is accessible across boundaries - middle managers are more vulnerable - their data is easily exposed".

No structural changes could be unequivocally associated with I.T., but what did emerge was a picture of boundaries, both hierarchical and functional, more traversable by information, and to an extent, by managers themselves. Increased transparency, and accessibility of data seems also to be linked with an increasing responsiveness of managerial and non-managerial processes. While these effects were found mostly in departments much involved in I.T. systems, there appeared to be similar, but slighter, effects beyond those departments.

5.2 Data Issues

As discussed in section 2 on Implementation, the numbers of terminals, screens, and PCs, and the availability of computer-produced data, has steadily increased over the years, and most managers regarded the systems-data component of their

roles, as large and important. Computer produced material had usually become a standard part of the job, and apart from comments about format-unfriendliness, or about difficulties of getting a format changed, was regarded as unremarkable. For instance, H-18, a tier manufacturing manager, apparently not using I.T., or especially interested in it, suddenly, in an interview, produced a highly complex print-out with all manner of computer-produced graphics, which it transpired, was central to his whole job. He claimed he spent 40% of his time on data issues (mostly based on computer information) and 5% on people issues).

Systems had often been installed ten to fifteen years earlier (for instance costing, and inventory) and had become accepted as the 'normal' hard-data infrastructure. This now traditional regime was being overtaken by the switch from batch to on-line, the spread of PCs, the telecommunication emphasis, and the impending installation of much more integrated systems (for instance in manufacturing). As in the other companies, it was important to understand the specifics of a system and its implications, especially the particular phase of an installation - early systems produced (and were still producing) voluminous print-outs which stimulated managers to complain of excessive quantity, or irrelevancy, while later schemes, using on-line screen access, were much more acceptable on these issues.

However, perceived increase in data quantity, and in information issues in their work, was most marked amongst the B/C group, as was the apparent utility of print-outs, and data timeliness.

The characteristics of I.T. which appeared to have the most remarked on effects were rapidity of processing or transmission, and accessibility of data, and these features are associated with the spread of the new genre of systems. Electronic mail was still rarely used by managers internally, but messaging over the international 'Hardware' electronic network was being used by some interviewed managers who found it very useful. But it was the spread of electronic data bases with their virtually

instantaneous access and display of needed information, and the links between customers and the company via networks, which were most mentioned - again mostly in the prime user area of marketing and distribution.

5.3 Oral Communication

Managers' roles were patently mainly oral, one-to-one, and in meetings, and increased time talking to both their seniors and their subordinates was often intimated. This was especially observed in marketing, sales and distribution departments, and in the production areas, where factory managers were immersed in a sea of direct personal contacts. These managers, often with more than one hundred subordinates, appeared to spend a large proportion of their time in talking to shop-floor workers and supervisors, and participating in many meetings - at least one per day - on a host of diverse subjects - stock control, costs, quality, cleaning, rejects, lockers for staff, overtime, tidiness, new installations.

In addition it was obvious that computer produced data was entering their work in a substantial way, and one of their problems was coping with the transition as the detailed people issues decreased, and the computer data issues increased. While this was true of all interviewed managers it was especially observable for factory managers, and in sales administration.

5.4 Summary

I.T. seemed to be reducing the previously inhibiting character of functional demarcations. In consequence a greater integration between departments was evident. The increased availability of screens and access to data was increasing organizational transparency which was seen by some managers as increasing their vulnerability.

Computer output was regarded as unremarkable by many managers: it had become routine.

Oral communication of all kinds continued to be a central and important part of most managers' work.

However, a transition of priorities was underway as detail personnel administration reduced, and computer system issues become more central.

6. MANAGERS AND DECISION MAKING

On all aspects of decision making, managers at 'Hardwear' appeared to have difficulties in defining and recalling their roles and behaviours. Decisions seemed to be so woven into the continuing stream of events, and so blurred by interactions with several people, and often committees, that they were rarely remembered as distinct events. Issues were often successively refined and changed, as more, and different, information became available, and as understanding altered. Decision making was patently closely associated with information transactions, and with interpersonal relationships.

6.1 Group Influence

In matters strategic, the guiding presence of 'Group' was omniscient, though several managers emphasised the consultative-participative relationships with 'Group'. Nevertheless, managers frequently gave the impression that they were not taking initiatives because 'Group' were working on the problem. The corporation had carried out a huge (European) rationalisation of product range, and of production facilities in the last five to seven years. Its consequences on 'Hardwear' in terms of manpower reduction, closure of facilities, reduction of product range, and of operations generally, were never far from the surface in discussions.

As discussed under 'I.T. culture' previously, this dominance of 'Group' was immanent in the I.T. field. A written down corporate 'Group' strategy was said to exist, though only the

M.D. actually claimed to have seen it, and this long-term plan conditioned 'Hardwear's I.T. local developments. For instance, 'Hardwear' awaited the installation of an all-embracing 'Group' computer based manufacturing system, and its own scheme had been abandoned in its favour.

Similarly, the corporation was working on an international project (B.E.D.A.) for holding all manufacturing and technical data on file at a central location (not in the U.K.). Again CAD/CAM (computer aided design, computer aided manufacturing) was being used in other units abroad, but not yet at 'Hardwear', although it was expected within a year.

Thus it seemed that 'Hardwear' managers were participating in the unfolding of the 'Group' I.T. plan. But the major I.T. packages were being designed abroad, with timing of implementation being much influenced by the corporation's head office.

6.2 Rapidity of data handling, and decisions

Rapidity of data handling was often mentioned in the context of decision making. It was clear that in several ways information was moving much more rapidly than hitherto, and also that the handling of data - that is, analysis and access - was much faster than five years earlier. Message switching within the international network was now virtually instantaneous, and implied a potential for near real-time consultation between 'Group' and 'Hardwear'. This facility was often mentioned, usually favourably, by senior managers, and the specialists who have been using the message network. Similarly, as reported earlier, the Marketing department regarded speed of data movement to, and from, customers, and access of data to customers, as a prime selling advantage. On the local site, there was as yet little use of electronic mail. However, much more rapid data handling, (as opposed to transmission), that is data collection, analysis and access, was widely remarked upon in the context of decisions. Data base availability, and usage had increased considerably, over recent years, and gave easier

and more rapid data access, when compared with older 'packages' with narrower data functionality (designed for limited tasks within, say, Marketing).

The spread of personal computers was also a cause of increased speed of access, and of analysis. For instance, H-15 (Finance) explained that "because of the use of PCs people are now thinking of a complete job, rather than splitting the task between several people". The implication was, more speed, and a less fragmented understanding by staff.

The effects which follow from increase in speed of transmission and speed of access are subtle, and certainly not easy to identify by managers. There was a tendency of managers to imply that faster access meant better decision making, and more flexibility of organizational response. H-3 (Finance): "The decisional role will not change but with more up-to-date information, decisions are better. A manager knows, more quickly after a decision, whether a risk is working ... though people do not yet understand the value of data".

HQ-14 (Technical): "Because of I.T. the service we give as a department, and that I give to my boss, and to our customers has improved considerably. I have much more information available to me now, and much more quickly - so I can make effective use of it". And in Marketing (H-2): "The sensible application of I.T. allows the emphasis of management and professionals, in particular, to shift from information gathering to making decisions based on rapid access to (exception) information ... key to accurate decisions is good fast data". And H-6 in Marketing: "(Due to I.T.) accurate information is available quickly - this enables decisions based on reliable data - we are able to respond to customer needs quickly, and with more accuracy. This comment by a very senior executive was echoed at a middle management level in Marketing by H-16. He explained that with instantaneous access to data via VDUs, he, and his staff were able to take decisions 'there and then' in response to telephoned enquiries from customers". This manager was now

manifestly aware of delays caused by a requirement to refer up decisions on some prices (variable only by his senior for quantity) - "More decisions could and should (because of availability of computer assistance) be made at my level".

H-9 in Technical felt that the increased use of I.T. based systems allowed lower level managers to run the basic activities, with more delegated responsibility, so releasing senior managers from some 'day-to-day' issues, enabling them to look at exceptional circumstances, and to be more planning and 'creativity' orientated.

6.3 Decision Support

Customer specification of products on receipt of customer application data, was being used. Whereas before, engineers would use their own experience and judgement about applications, now this knowledge had been codified into a computer package. Whilst the overseeing of this process was still carried out by engineers, it is the early stage of an "Intelligent Knowledge Based System". This approach was partly adopted because of increased customer stringency on specification and price, - computer-derived specifications could be more accurate, and much more rapid.

In production, warehouse assignment and in marketing, the movement toward computer-assisted, or computer-guided, decision making was quoted. Every single product coming off the production line was sensed for quality and dimensional accuracy by a fully automatic computer controlled system, which fed correcting tooling data to the appropriate machines. This was a case where several tasks involving manual quality control and the associated decision making in terms of corrective measures had been integrated into a single complex computer driven system. A similar case was in the bonus payments system in which a computer arrangement measured and recorded product output on several production lines, and calculated workers' bonus payments according to a complex set of guidelines. Here

again, various previous tasks, some shop floor manual, some office based paper transactions, and some decision making, had been designed into a single I.T. system. As ROTHWELL (1984) reports, in these kinds of instances, discretionary decisions previously made by supervisors become absorbed by the computer system.

The process of decision making seemed to be less focussed on specific functions, departments, tiers, or even on 'Hardware' itself. Because of the increasingly widespread web of fast data access, traversing all functions, and including 'Group' and some customers, decision making was taking on a 'network' character. Many managers talked of the necessity for a broader, integrated, less parochial, management pervue, and the blurring of demarcations of all kinds.

There were several differences in decision ambience between B/C managers (much involved with I.T.), and D managers (little I.T. involvement). The former felt their authority to take decisions, their emphasis on strategic, vis-a-vis tactical, issues, their time horizon, and the planning elements in their role had all distinctly increased over the last five years. D managers claimed these job factors had remained the same.

6.4 Summary

As at 'Engineering', managers had difficulty in recalling and defining their decision roles and behaviours.

The influence of the corporate headquarters ('Group') was important and continuous in decision making at 'Hardware'.

Rapidity of data handling, analysis and transmission was regarded favourably in decision making. Near real-time consultations between 'Group' and the company, and between customers and the Marketing department, facilitated by I.T. was especially remarked upon.

Some decisions have been absorbed into the computer system and early stages of computer assistance in decision making were evident. Decision mechanisms are taking on a 'network' character because of the extending web of fast access to data bases and consultation. I.T. seems to be creating a broader view of company operations by managers.

7. SUMMARY OF I.T. EFFECTS

Computing has been well established in 'Hardware' for twenty years, yet the major part of its activities has continued largely without I.T. interventions. Only in the last three or four years, with advances in the technology, particularly in cost reduction, personal computing, telecommunications and software engineering, has a more favourable climate for I.T. diffusion developed.

Although there is, it is claimed, a written-down 'Group' strategy for I.T., local managers are largely unaware of that plan. Nor is there apparent evidence of management considerations of organizational implications of I.T. - nearly half the interviewed managers believe there is no plan for I.T. Implementation has, therefore, proceeded in a tactical fashion, responding to, and being limited by, the various levels of knowledge, enthusiasm and imagination amongst managers. There is a monthly meeting of Directors on computing which dealt mostly with priority settings, and checking progress of systems developments.

It was universally agreed that Marketing has moved most quickly into I.T. based operation and that, paradoxically, Finance in which computer involvement had started twenty years ago, had little zeal until very recently. There was unanimity also that Technical and Manufacturing were lagging, and that the Personnel function had hardly any involvement in I.T. A clear functional differentiation of I.T. applications and implications is therefore apparent. No revolution was seen, although there appeared to be quickening of interest in, and an acceleration

of, I.T. involvement over the last two or three years.

A clear division of surveyed managers into an I.T.-involved group (B/C's) and a 'slightly involved' or 'uninvolved' group (D's) is discernable. The two groups evince rather different views of management and I.T. issues. But a changing organizational culture associated with information technology is evident in most managers' comments, in whichever group. I.T. is commonly quoted as one of the major sources of change in recent years. The reduction in personnel at 'Hardwear' (from 5,800 in 1970 to 1,100 in 1984) is mainly due to manufacturing and product rationalisation, and effectively blurs the labour effects of I.T. applications. Nevertheless, managers were able to show in several cases that increased sophistication of, and increased use of, computer systems did produce productivity gains, and manpower reductions. Generally reports are of greater reduction of lower skilled people, so that the proportion of professional and skilled personnel has increased.

Managers frequently report insufficient levels of training for themselves and their staff in preparation for I.T. applications. Indeed, training of all types is regarded as scant.

Computer applications have been firstly in repetitive, 'low intelligence' functions such as wage administration, and costing. At the time of the study highly sophisticated and integrated systems were about to be introduced in manufacturing, and the expectations of managers are that these wide-scale applications will produce considerable organizational implications. Computer-driven systems are thus absorbing increasingly higher intelligence tasks, with effects on an increasingly broad spectrum of managers and functions.

As I.T. spreads, speed of data transmission, and data access, quickens, boundaries become less hard, and, in general, organizational transparency becomes greater. This is associated by managers with vulnerability. Coupled with this is an expressed need for integration of functions and tasks, and a

more inclusive management approach. The time horizon (focal point ahead) of I.T.-involved managers seems to be longer with more concern with strategic issues. There is widespread reference to 'changing' and 'increased' skills associated with the new technologies, and amongst the B/C group observations of increased 'professionalism' and 'calibre' of staff. Managers consistently report they spent more time on people issues (in spite of there being less staff), though industrial relations issues are rarely reported. Oral communication remains dominant in management roles.

Communication forms a large component of all the managerial jobs, and most managers regard information transactions as a key element. Computer-produced material has usually become a routine, and often unremarked on, part of their milieu. The I.T.-involved group are most aware of data parameters such as quantity, timeliness and ability.

The rapidity of transmission of data, and accessibility of data, are the I.T. characteristics most commented on, and valued. Transmission speed, and data accessibility, mean more frequent interaction between managers, and between managers and the data, and a gradual movement toward 'real time' management.

There is an absorption into the computer system of some data collection and sensing activities, and some decision making (for instance assignment), and evidence of some elementary intelligent-knowledge-based systems.

Decision making was difficult for managers to describe, though accessibility of data, and system rapidity was thought to improve decisions. Decision mechanisms appear to be taking on a 'network' quality because of the web of I.T. driven data bases, and the fast consultation possible.

A Comparative Note

'Hardwear' and 'Engineering', although having uniquely different

cultures, share many similarities. They are both foreign-owned multi-nationals, in mechanical engineering, with long established products and have for the last ten years or so experienced vigorous competition - for which it seems they were underprepared.

Some cultural-structural features are similar: traditional, well-defined functional demarcation and hierarchy; weakness in training and especially management training; conservative ambience; financial losses over the last decade; little inherent experience of electronics; twenty year history of 'conventional' main-frame computing. On the other hand there are dissimilarities: 'Engineering' had ten times the labour force, a much more complex organization, and probably a more conservative, risk-averse environment.

The characteristics of managers' work in the literature hold in both companies. Managers tend to have busy, highly fragmented, action-orientated work, with much attention-switching and oral communication.

Almost without exception the patterns of I.T. implementation and its effects on managers are similar.

Both companies have decades of computing experience, but primarily using 'isolated' main-frames to handle transaction processing. It is in the last five years that I.T. has become strategically important from a corporate viewpoint, and this has coincided with the spread of terminals and personal computers amongst managers, and functions.

I.T. implementation is proceeding largely in a tactical manner with no explicit, and well-known plan, nor much preparatory training for managers. Each function is taking up I.T. in a specific way, with low complexity, high volume, transaction processing in the Finance department being the earliest user. Technical and Manufacturing tended to be less I.T.-involved until recently, and Personnel usage is slight. In both

companies the Marketing function has over the last two or three years become enthusiastic about the potential of I.T., both for decision support, and for fast telecommunications. The availability of personal computers, and networking, in recent years is a source of a more favourable acceptance of I.T. by users.

Cost reduction as productivity increase appears to have been the principle early motivation for using I.T., though added value is now emerging as a later incentive.

Both companies are shrinking in size (for a given turnover), partly due to technology, and structure is flattening and becoming simpler. Functional and hierarchical boundaries are becoming less inhibiting of data flow, and of consultation between managers. Integration between functions is improved with managers taking a broader, longer term view of their business. Where I.T. is heavily used both managers and non-managers appear to be enthused with a new sense of initiative taking and flexibility.

In these two companies it seems that important cultural changes are being stimulated by the spread of I.T. Traditional, rather mechanistic management approaches are giving way to a new ambience.